Representative to National Research Council.
W. A. Riley, St. Paul, Minn. Term expires 1932.
J. E. Graf, (Alternate), Washington, D. C. Term expires June 30, 1931.

Councillors for the American Association for the Advancement of Science.
W. E. Hinds, Baton Rouge, La.
M. H. Swenk, Lincoln, Neb.

Trustees for Crop Protection Institute.
P. J. Parrott, Geneva, N. Y. Term expires 1931.
W. P. Flint, Urbana, Illinois. Term expires 1930.
W. C. O'Kane, Durham, N. H. Term expires 1932.

Representatives on Council of Union of American Biological Societies.
A. L. Quaintance, Washington, D. C.
C. R. Crosby, Ithaca, N. Y.

Representative on Board of Trustees of Tropical Plant Research Foundation.
Herbert Osborn, Columbus, Ohio.

Committee on Recommendations to Secretary of Agriculture with Reference to Needs for Foreign Stations to Study Insect Pests, Plant and Animal Diseases Introduced or Likely to be Introduced. (To cooperate with Phytopathologists.)
Herbert Osborn, Chairman, Columbus, Ohio.
E. O. Essig, Berkley, California.
G. W. Herrick, Ithaca, N. Y.

Committee on Training of Entomologists.
W. C. O'Kane, Chairman, Durham, N. H.
W. A. Riley, St. Paul, Minn.
A. C. Baker, Washington, D. C.
C. J. Drake, Ames, Iowa.
H. J. Quayle, Riverside, Calif.

Committee to Formulate Plans for Investigation of the Codling Moth from Biologic and Control Standpoints.
A. L. Quaintance, Chairman, Washington, D. C. Term expires 1931.
B. A. Porter, Washington, D. C. Term expires 1931.
G. A. Dean, Manhattan, Kans. Term expires 1930.
Leroy Childs, Hood River, Oregon. Term expires 1930.
P. J. Parrott, Geneva, N. Y. Term expires 1932.
W. A. Ross, Vineland Station, Ontario, Can. Term expires 1932.

LIST OF MEETINGS AND PAST OFFICERS

First Annual Meeting, Washington, D. C., Nov. 12–14, 1889. President, C. V. Riley; Vice-President, S. A. Forbes; Second Vice-President, A. J. Cook; Secretary, John B. Smith.

Second Annual Meeting, Champaign, Ill., Nov. 11–13, 1890. (The same officers had charge of this meeting.)

Third Annual Meeting, Washington, D. C., Aug. 15–18, 1891. President, James Fletcher; First Vice-President, F. H. Snow; Second Vice-President, Herbert Osborn; Secretary, L. O. Howard.

Fourth Annual Meeting, Rochester, N. Y., Aug. 15–16, 1892. President, J. A. Lintner; First Vice-President, S. A. Forbes; Second Vice-President, J. H. Comstock; Secretary, F. M. Webster.

Fifth Annual Meeting, Madison, Wisc., Aug. 14–16, 1893. President, S. A. Forbes; First Vice-President, C. J. S. Bethune; Second Vice-President, John B. Smith; Secretary, H. Garman.

Sixth Annual Meeting, Brooklyn, N. Y., Aug. 14–15, 1894. President, L. O. Howard; First Vice-President, John B. Smith; Second Vice-President, F. L. Harvey Secretary, C. P. Gillette.

Seventh Annual Meeting, Springfield, Mass., Aug. 27–28, 1895. President, John B. Smith; First Vice-President, C. H. Fernald; Secretary, C. L. Marlatt.

Eighth Annual Meeting, Buffalo, N. Y., Aug, 21–22, 1896. President, C. H. Fernald; First Vice-President, F. M. Webster; Second Vice-President, Herbert Osborn; Secretary, C. L. Marlatt.

Ninth Annual Meeting, Detroit, Mich., Aug. 12–13, 1897. President, F. M. Webster; First Vice-President, Herbert Osborn; Second Vice-President, Lawrence Bruner; Secretary, C. L. Marlatt.

Tenth Annual Meeting, Boston, Mass., Aug. 19–20, 1898. President, Herbert Osborn; First Vice-President, Lawrence Bruner; Second Vice-President, C. P. Gillette; Secretary, C. L. Marlatt.

Eleventh Annual Meeting, Columbus, Ohio, Aug. 18–19, 1899. President, C. L. Marlatt; First Vice-President, Lawrence Bruner; Second Vice-President, C. P. Gillette; Secretary, A. H. Kirkland.

Twelfth Annual Meeting, New York, N. Y., June 22–23, 1900. President, Lawrence Bruner; First Vice-President, C. P. Gillette; Second Vice-President, E. H. Forbush; Secretary, A. H. Kirkland.

Thirteenth Annual Meeting, Denver, Colo., Aug. 23–24, 1901. President, C. P. Gillette; First Vice-President, A. D. Hopkins; Second Vice-President, E. P. Felt; Secretary, A. L. Quaintance.

Fourteenth Annual Meeting, Pittsburgh, Pa., June 27–28, 1902. President, A. D. Hopkins; First Vice-President, E. P. Felt; Second Vice-President, T. D. A. Cockerell; Secretary, A. L. Quaintance.

Fifteenth Annual Meeting, Washington, D. C., Dec. 26–27, 1902. President, E. P. Felt; First Vice-President, W. H. Ashmead; Second Vice-President, Lawrence Bruner; Secretary, A. L. Quaintance.

Sixteenth Annual Meeting, St. Louis, Mo., Dec. 29–31, 1903. President, M. V. Slingerland; First Vice-President, C. M. Weed; Second Vice-President, Henry Skinner; Secretary, A. F. Burgess.

Seventeenth Annual Meeting, Philadelphia, Pa., Dec. 29–30, 1904. President, A. L. Quaintance; First Vice-President, A. F. Burgess; Second Vice-President, Mary E. Murtfeldt; Secretary, H. E. Summers.

Eighteenth Annual Meeting, New Orleans, La., Jan. 1–4, 1906. President, H. Garman; First Vice-President, E. D. Sanderson; Second Vice-President, F. L. Washburn; Secretary, H. E. Summers.

Nineteenth Annual Meeting, New York, N. Y., Dec. 28–29, 1906. President, A. H. Kirkland; First Vice-President, W. E. Britton; Second Vice-President, H. A. Morgan; Secretary, A. F. Burgess.

Twentieth Annual Meeting, Chicago, Ill., Dec. 27–28, 1907. President, H. A. Morgan; First Vice-President, H. E. Summers; Second Vice-President, W. D. Hunter; Secretary, A. F. Burgess.

Twenty-first Annual Meeting, Baltimore, Md., Dec. 28–29, 1908. President, S. A. Forbes; First Vice-President, W. E. Britton; Second Vice-President, E. D. Ball; Secretary, A. F. Burgess.

Twenty-second Annual Meeting, Boston, Mass., Dec. 28–29, 1909. President, W. E. Britton; First Vice-President, E. D. Ball; Second Vice-President, H. E. Summers; Secretary, A. F. Burgess.

Twenty-third Annual Meeting, Minneapolis, Minn., Dec. 28–29, 1910. President, E. D. Sanderson; First Vice-President, H. T. Fernald; Second Vice-President, P. J. Parrott; Secretary, A. F. Burgess.

Twenty-fourth Annual Meeting, Washington, D. C., Dec. 27–29, 1911. President, F. L. Washburn; First Vice-President, E. D. Ball; Second Vice-President, R. H. Pettit; Secretary, A. F. Burgess.

Twenty-fifth Annual Meeting, Cleveland, Ohio, Jan. 1–3, 1913. President, W. D. Hunter; First Vice-President, T. J. Headlee; Second Vice-President, R. A. Cooley; Secretary, A. F. Burgess.

Twenty-sixth Annual Meeting, Atlanta, Ga., Dec. 31, 1913–Jan. 2, 1914. President, P. J. Parrott; First Vice-President, E. L. Worsham; Second Vice-President, Wilmon Newell; Secretary, A. F. Burgess.

Twenty-seventh Annual Meeting, Philadelphia, Pa., Dec. 28–31, 1914. President, H. T. Fernald; First Vice-President, Glenn W. Herrick; Second Vice-President W. E. Britton; Third Vice-President, Wilmon Newell; Secretary, A. F. Burgess.

Special Meeting, Berkeley, Cal., Aug. 9–10, 1915. (Officers same as for Twenty-eighth Annual Meeting.)

Twenty-eighth Annual Meeting, Columbus, Ohio, Dec. 27–30, 1915. President, Glenn W. Herrick; First Vice-President, R. A. Cooley; Second Vice-President, W. E. Rumsey; Third Vice-President, E. F. Phillips; Secretary, A. F. Burgess.

Twenty-ninth Annual Meeting, New York, N. Y., Dec. 28–30, 1916. President, C. Gordon Hewitt; First Vice-President, G. A. Dean; Second Vice-President, E. D. Ball; Third Vice-President, W. J. Schoene; Fourth Vice-President, T. J. Headlee; Secretary, A. F. Burgess.

Thirtieth Annual Meeting, Pittsburgh, Pa., Dec. 31, 1917–Jan. 2, 1918. President, R. A. Cooley; First Vice-President, W. E. Hinds; Second Vice-President, A. W. Morrill; Third Vice-President, G. M. Bentley; Fourth Vice-President, B. N. Gates; Secretary, A. F. Burgess.

Thirty-first Annual Meeting, Baltimore, Md., Dec. 26–27, 1918. President, E. D. Ball; First Vice-President, W. C. O'Kane; Second Vice-President, G. P. Weldon; Third Vice-President, E. C. Cotton; Fourth Vice-President, Franklin Sherman, Jr.; Secretary, A. F. Burgess.

Thirty-second Annual Meeting, St. Louis, Mo., Dec. 31, 1919–Jan. 2, 1920. President, W. C. O'Kane; First Vice-President, A. G. Ruggles; Second Vice-President, H. J. Quayle; Third Vice-President, E. C. Cotton; Fourth Vice-President, W. E. Britton; Secretary, A. F. Burgess.

Thirty-third Annual Meeting, Chicago, Ill., Dec. 29–31, 1920. President Wilmon Newell; First Vice-President, H. A. Gossard; Second Vice-President, E. M. Ehrhorn; Third Vice-President, J. G. Sanders; Fourth Vice-President, F. B. Paddock; Secretary, A. F. Burgess.

Thirty-fourth Annual Meeting, Toronto, Canada, Dec. 29–31, 1921. President, George A. Dean; First Vice-President, Arthur Gibson; Second Vice-President, E. O. Essig; Third Vice-President, A. G. Ruggles; Fourth Vice-President, H. F. Wilson; Secretary, A. F. Burgess.

Thirty-fifth Annual Meeting, Boston, Mass., Dec. 28–30, 1922. President, J. G. Sanders; First Vice-President, J. M. Swaine; Second Vice-President, A. L. Lovett; Third Vice-President, R. W. Harned; Fourth Vice-President, M. C. Tanquary; Secretary, A. F. Burgess.

Thirty-sixth Annual Meeting, Cincinnati, Ohio, Dec. 29, 1923–Jan. 2, 1924. President, A. G. Ruggles; First Vice-President, H. A. Gossard; Second Vice-President, H. J. Quayle; Third Vice-President, P. A. Glenn; Fourth Vice-President, S. B. Fracker; Secretary, A. F. Burgess.

Thirty-seventh Annual Meeting, Washington, D. C., Dec. 31, 1924–Jan. 3, 1925. President, A. F. Burgess; First Vice-President, M. C. Tanquary; Second Vice-President, H. S. Smith; Third Vice-President, E. R. Sasscer; Fourth Vice-President, R. W. Harned; Secretary, C. W. Collins.

Thirty-eighth Annual Meeting, Kansas City, Mo., Dec. 29, 1925–Jan 1, 1926. President, H. A. Gossard (died in office December 18, 1925); First Vice-President, R. N. Chapman (assumed duties of President for remainder of term); Second Vice-President, Leroy Childs; Third Vice-President, C. H. Hadley; Fourth Vice-President, R. L. Webster; Secretary, C. W. Collins.

Thirty-ninth Annual Meeting, Philadelphia, Pa., Dec. 28, 1926–Jan. 1, 1927. President, Arthur Gibson; First Vice-President, C. J. Drake; Second Vice-President, W. B. Herms; Third Vice-President, L. A. Strong; Fourth Vice-President, J. I. Hambleton; Fifth Vice-President, W. E. Hinds; Secretary, C. W. Collins.

Fortieth Annual Meeting, Nashville, Tenn., Dec. 27–31, 1927. President, R. W. Harned; First Vice-President, W. P. Flint; Second Vice-President, R. W. Doane; Third Vice-President, Franklin Sherman; Fourth Vice-President, J. H. Montgomery; Fifth Vice-President, F. E. Millen; Secretary, C. W. Collins.

Forty-first Annual Meeting, New York, N. Y., December 27–31, 1928. President, W. B. Herms; First Vice-President, J. E. Graf; Vice-Presidents, R. S. Woglum (Pacific Slope Branch); G. M. Bentley (Cotton States Branch); P. J. Parrott (Eastern States Branch); L. S. McLaine (Section of Plant Quarantine and Inspection); H. F. Wilson (Section of Apiculture); Secretary, C. W. Collins, Melrose Highlands, Mass.

Forty-second Annual Meeting, Des Moines, Iowa, December 30, 1929–January 2, 1930. President, T. J. Headlee; First Vice-President, E. R. Sasscer; Vice-Presidents, O. H. Swezey, ((Pacific Slope Branch); F. L. Thomas, (Cotton States Branch); E. N. Cory, (Eastern States Branch); F. N. Wallace, (Section of Plant Quarantine and Inspection); G. M. Bentley, (Section of Apiculture); J. A. Hyslop, (Section of Extension); Secretary, C. W. Collins, Melrose Highlands, Mass. (T. H. Jones, Secretary Pro-tem for the Des Moines meeting).

LIST OF MEMBERS

ACTIVE MEMBERS

Abbott, W. S., U. S. Bureau of Entomology, Vienna, Va.
Ackerman, A. J., U. S. Bureau of Entomology, Washington, D. C.
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Baker, A. W., Ontario Agricultural College, Guelph, Canada.
Baker, F. E., Japanese Beetle Laboratory, Moorestown, N. J.
Baker, Howard, Box 1715, Shreveport, La.
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Beckwith, C. S., Cranberry Exp. Sta., Pemberton, N. J.
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†Bentley, G. M., University of Tennessee, Knoxville, Tenn.
Berger, E. W., University of Florida, Box 656, Gainesville, Fla.
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†Bilsing, S. W., College Station, Texas.

†Members who attended 1929 meeting.

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*Life members.
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Townsend, L. H., Univ. of Ill., Urbana, Ill.
Toyne, Arthur, 112 E. Ave., 41, Los Angeles, Calif.

†Members who attended 1929 meeting.

Tuckett, J. E., Indio, Calif.
Turner, Neeley, Exp. Sta., New Haven, Conn.

†Ulman, P. T., European Corn Borer Control, Auburn, Ind.

Van Aller, T. S., 902 Charleston St., Mobile, Ala.
Van der Meulen, P. A., Rutgers Univ., New Brunswick, N. J.
Vaughan, E. A., Box 4044, Tampa, Fla.
Vickery, R. K., Watsonville, Calif.

Wagner, G. B., Dep't Ent., K. S. A. C., Manhattan, Kans.
Walkden, H. H., 126 S. Minneapolis Ave., Wichita, Kan.
Walker, H. G., 208 E. Northwood Ave., Columbus, Ohio.
†Wall, R. E., 1506 Raymond Ave., St. Paul, Minn.
†Wallis, R. L., Melrose Hlds., Mass.
Walsh, S. G., address unknown.
Watson, L. R., Alfred, N. Y.
†Watts, H. R., 120 S. Fourth St., Louisville, Ky.
Webb, R. J., Drawer 359, Monroe, Mich.
Weed, C. M., State Normal School, Lowell, Mass.
Wells, A. B., 24 Depot Lane Sta., Flushing, Long Island, N. Y.
Wells, R. W., 1162 E. Main St., Galesburg, Ill.
Werner, W. H. R., Univ. of Mich., Ann Arbor, Mich.
West, L. S., Battle Creek College, Battle Creek, Mich.
Wheeler, A. J., Madison, Tenn.
†Whitehead, T. E., Okla. A. & M. Coll., Stillwater, Okla.
Whitmarsh, R. D., Lake Winnemissett, Deland, Fla.
†Wilbur, D. A., K. A. C., Manhattan, Kansas.
Willey, C. R., Room 1112, State Office Bldg., Richmond, Va.
Williams, L. L., Box 123, Wyoming, Del.
Williams, V. E., 1324 Elm St., San Gabriel, Calif.
Williams, V. V., Box 1222, Calexico, Calif.
Williamson, Warren, R. D. 5, Galesburg, Ill.
Wilson, G. R., 1620 Santa Clara Ave., Alameda, Calif.
Winchester, H. I., U. S. Bureau of Entomology, Melrose Highlands, Mass.
Wisecup, C. B., Sanford, Fla.
Wolfenbarger, D. O., Brookings, S. D.
Woodhams, G. E., Sta. Dept. Agr., Sacramento, Calif.
†Woodruff, L. C., 1212 Louisiana St., Lawrence, Kan.
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Wooldridge, Reginald, U. S. Bureau of Entomology, Melrose Highlands, Mass.
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Wright, P. F., 211 Chestnut St., Lodi, Calif.

Yeates, J. M., Box 374, Tallulah, La.
York, C. H., 542 Jefferson St., Pomona, Calif.
York, G. T., 213 N. 11th St., Corvallis, Oregon.
Young, H. C., Box 1257, Tucson, Ariz.

†Members who attended 1229 meeting.

Young, H. D., Bureau Chemistry and Soils, Washington, D. C.

Zeimet, Carlo, Bureau of Entomology, Washington, D. C.
Ziegler, L. W., 310 Washington St., Gainesville, Fla.
Zimmerman, Mrs. H. K., 317 Kensington Ave., Astoria, Oregon.

Total Number of Associate Members, 519.

FOREIGN MEMBERS

Anderson, T. G., Nairobi, British East Africa.
Aulló, Costilla, Dr. Manuel, Laboratorio de la Fauna Forestal Espanola, Ferraz, 40 Madrid, Spain.

Ballou, H. A., West Indian Agricultural College, St. Augustine, Trinidad, West Indies.
Bordage, Edmond, Directeur de Musee, St. Denis, Reunion.
Brain, Charles K., University of Stellenbosch, Stellenbosch, C. P. South Africa.

Carpenter, Dr. George H., University of Manchester, Manchester, England.
Collinge, W. E., 55 Newhall St., Birmingham, England.

Danysz, J., Laboratorie de Parasitologie, Bourse de Commerce, Paris, France.
DeBussy, L. P., Kolonial Instit., Mauritskade 65–66, Amsterdam, Holland.

Escherisch, K., Forstliche Versuchsaustalt, Universitat, Munich, Germany.

Filipjev, T. N., Certzena 44, Leningrade, Russia.
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Froggatt, W. W., 12 Young St., Croyden, Sydney, New South Wales.

Goding, F. W., Box 448, Livermore Falls, Maine, U. S. A.
Grasby, W. C., 6 West Australian Chambers, Perth, West Australia.
Green, E. E., Way's End, Beach Ave., Camberley, Surry, England.

Herrera, A. L., Director de Estudios, Bibliogicas, Secretaria de Agricultura y Formento, Mexico, D. F. Mexico.
Hill, Gerald F., 5 Clifton Rd., Hawthorn, Melbourne, Australia.
Horvath, Dr. G., Museum Nationale Hungaricum, Budapest, Hungary.

Jablonowski, Josef, Entomological Station, Budapest, Hungary.
Jack, Rupert W., Salisbury, Rhodesia, South Africa.
Johnson, Thomas H., University of Brisbane, Queensland, Australia.

Kulagin, Nikolai M., Petrovsky-Rasumovsky Academy, Petrovsko-Rasumovskoie, Moscow, Russia.
Kuwana, S. I., Imperial Agricultural Experiment Station, Yokohama, Japan.

Lea, A. M., National Museum, Adelaide, South Australia.
Lounsbury, Charles P., 795 Church St., East, Pretoria, South Africa.

Mally, C. W., University of Stellenbosch, Stellenbosch, C. P., South Africa.
Marchal, Dr. Paul, 16 Rue Claude-Bernard, Paris, France.
Mokrzecki, Dr. Sigismond, Director, Instit. of Forest Protection and Entomology, Skierniewice, Poland.
Mussem, Charles T., Hawkesbury Agricultural College, Richmond, New South Wales.

Nawa, Yashushi, Entomological Laboratory, Kyomachi, Gifu, Japan.
Newstead, Robert, University School of Tropical Medicine, Liverpool, England.

Parker, Theodore, Leeds University, Leeds, England.
Porter, Carlos E., Casilla 2352, Santiago, Chili.
Pospielow, Dr. Waldemar, Bureau of Entomology, Morskaya 44, Petrograd, Russia.

Read, Charles S., Mendoza, Argentine Republic, South America.
Rosenfeld, A. H., Am. Sugar Cane League, 1005 New Orleans Bank Bldg., New Orleans, La.
Ruzkowski, J. W., Solacka, Poznau, Poland.

Sajo, Prof. Karl, Godollo-Veresegyhaz, Hungary.
Scaramuzza, L. C., Camaguey, Cuba.
Schoyen, Prof. W. M., Zoological Museum, Christiana, Norway.
Severin, Prof. G., Curator Natural History Museum, Brussels, Belgium.
Silvestri, Dr. F., R. Scuola Superiore di Agricoltura, Portici, Italy.
Stellwag, Dr. Friedrich, Neustadt, A. d. Haardt, Germany.

Theobald, Frederick V., Wye Court, Wye, Kent, England.
Thompson, Rev. Edward H., Franklin, Tasmania.
Tillyard, R. J., Cawthron Institute of Scientific Research, Nelson, New Zealand
Trâhärdh, Ivor, Experimental Faltat, Stockholm, Sweden.
Trouvelot, Bernard, Inst. Agr. Research, Paris, France.
Tryon, H., Queensland Museum, Brisbane, Queensland, Australia.

Urich, F. W., Department of Agriculture, Port of Spain, Trinidad, West Indies.

Total Number of Foreign Members, 51.
Grand Total of Members, 1150.

Forty-third Annual Meeting

of the

American Association of Economic Entomologists

Cleveland, Ohio

December 29, 1930 to January 2, 1931

Forty-Third Annual Meeting of the American Association of Economic Entomologists, Cleveland, Ohio

DECEMBER 29, 1930 TO JANUARY 2, 1931

The 43rd annual meeting of the American Association of Economic Entomologists will be held at Cleveland, Ohio, on the above dates. All sessions will be held in Room 24, Electricity Building, Case School of Applied Science. The Schedule has been arranged as follows:

Monday, December 29, Section of Apiculture; session 1:30 P. M.

Tuesday, December 30, Section of Quarantine and Inspection; sessions 10:00 A.M., and 1:30 P.M.

Wednesday, December 31, opening session of the general Association 10:00 A.M., afternoon session 1:30 P.M.

Thursday, January 1, sessions of the general Association in the morning and afternoon. Section of Extension Entomologists will be held in the evening.

Friday, January 2, morning session of the general Association. Final session in the afternoon.

OTHER MEETINGS

Annual meeting of the American Association for the Advancement of Science, its sections and affiliated societies, will be held December 30, 1930 to January 2, 1931.

The Entomological Society of America will meet on Tuesday and Wednesday, December 30 and 31. The public address before that society will be given on Tuesday evening.

HOTEL HEADQUARTERS

Hotel Headquarters for this Association will be at the Hollanden Hotel, Superior Avenue and East 6th Street. The following rates have been secured:

Single rooms	$3.00 up
Double rooms	6.00 up

(All rooms with baths)

RAILROAD RATES

Reduced rates have been secured which apply to practically all of the United States and Canada on the certificate plan. The traveler when purchasing his ticket should pay the full one-way fare and request a

certificate for the meeting of the American Association for the Advancement of Science. This certificate must be deposited for validation at the registration office which will be located in the gymnasium of the Western Reserve University. The registration fee for each ticket is one dollar for members of the American Association for the Advancement of Science and two dollars for all others. This certificate will be accepted for return passage at one-half the one-way rate.

Entomologists Dinner

The Entomologists Dinner will be held on Wednesday Evening, December 31. The exact time and place will be announced at the meeting.

Membership

Applications for membership can be secured from the Secretary or from the committee on membership. They should be filled out, properly endorsed and filed with the Membership Committee on or before December 31, and must be accompanied by a fee of $4.00.

Program

Monday Afternoon Session, December 29, 1:30 Room 24, Electricity Building, Case School of Applied Science

Section of Apiculture

R. L. Parker, *Chairman* — F. B. Paddock, *Secretary*

Appointment of Committees.

Address by the Chairman, R. L. Parker, Manhattan, Kansas.

Symposium on Honey. This symposium will be led by—

E. F. Phillips, Ithaca, N. Y.
H. F. Wilson, Madison, Wisc.
F. B. Paddock, Ames, Iowa.

General discussion.

1. A Colony of Bees Exposed to High External Temperatures—W. E. Dunham, Columbus, Ohio.

2. Metabolism of the Adult Honey Bee—M. D. Farrar, Urbana, Ill.

Discussion of the most pressing apicultural problems.

Reports of Committees.

Selection of Officers.

Adjournment.

Tuesday, December 30, Field trip to A. I. Root Co. plant, Medina, Ohio. leaving Cleveland at 10 A. M.

Program

Tuesday Morning Session, December 30, 10:00 Room 24, Electricity Building, Case School of Applied Science.

SECTION OF PLANT QUARINTINE AND INSPECTION

E. N. CORY, *Chairman* S. B. FRACKER, *Secretary*

Appointment of Committees on Resolutions and on Nominations.
Address by the Chairman, E. N. Cory, College Park, Maryland.

1. Review of the Work of the Plant Quarantine and Control Administration for the past year. L. A. Strong, Washington, D. C.

2. Progress in Mediterranean Fruit Fly Eradication. W. C. O'Kane, Durham, N. H.

3. The Present Status of the European Corn Borer in the United States. L. H. Worthley, Boston, Mass., and E. G. Brewer, Toledo, Ohio.

4. The European Corn Borer Situation in Ontario in 1930. L. S. McLaine, Entomological Branch, Department of Agriculture, Ottawa, Canada, and Lawson Caesar, Ontario Agricultural College, Guelph, Ont.

5. The Eradication of Isolated Gipsy Moth Outbreaks. A. F. Burgess, Melrose Highlands, Mass.

6. Plant Quarantine Policies and Procedure in Cuba. Ernesto Sanchez Estrada, Department of Agriculture, Commerce and Labor. Havana, Cuba.

Program

Tuesday Afternoon Session, December 30, 1:30; Room 24, Electricity Building, Case School of Applied Science

SECTION OF PLANT QUARANTINE AND INSPECTION

7. Recent Developments in the Problem of the Removal of Arsenical Residues. D. F. Fisher, Washington, D. C.

8. Comments on the Certification of Apples for Export to Great Britain. A. W. Gilbert, Boston, Mass.

9. Humid Heat as a Treatment to Eliminate Infestation—A Preliminary Report. Lon A. Hawkins, Washington, D.C.

10. Legal and Practical Aspects of the Relationships between the Federal and State Quarantine Officers and between National and Regional Plant Boards. Thos. J. Headlee, New Brunswick, N. J.

11. Bacterial Canker of Tomato and its Distribution with the use of seed from Diseased Fruits. L. M. Fenner, Columbus, Ohio.

12. Export Certification—Policies and Results. E. R. Sasscer, Washington, D. C.

13. Recent Investigational Work on Fumigation in Florida. A. F. Camp, Gainesville, Fla.

14. The Present Status of Sweet Potato Weevil Control and Certification in Texas. J. S. Woodard, Austin, Texas.

15. Report of the National Plant Board—including special report on the principles of Plant Quarantines. R. W. Leiby, Raleigh, N. C.

16. Reports of the Regional Boards:

The Eastern Plant Board. T. J. Headlee, Chairman, New Brunswick, N. J.

The Southern Plant Board. B. P. Livingston, Chairman, Montgomery, Ala.

The Central Plant Board. E. L. Chambers, Chairman, Madison, Wisc.

The Western Plant Quarrantine Board. W. C. Jacobsen, Secretary, Sacramento, Calif.

Report of Resolutions Committee.
Report of Nominating Committee.
Selection of Officers.
Adjournment.

Program

Wednesday Morning Session, December 31, 10; Room 24, Electricity Building, Case School of Applied Science

AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Report of the Secretary.

Report of the Executive Committee, by President Franklin Sherman.

Report of the Representative to the National Research Council, by W. A. Riley, St. Paul, Minn.

Report of the Governors of the Crop Protection Institute, by W. C. O'Kane, Durham, N. H.

Report of Scientific Trustee, Tropical Plant Research Foundation, by Herbert Osborn, Columbus, Ohio.

Report of the Representative on the Council of the Union of Biological Societies, by A. L. Quaintance, Washington, D. C.

Report of the Committee on Nomenclature, by J. A. Hyslop, Washington, D.C.

Report of Committee on Endowment, by A. F. Burgess, Melrose Highlands, Mass.

Report of Editorial Board on Index to Economic Entomology, by E. P. Felt, Stamford, Conn.

Report of Board of Trustees for Permanent Fund, by A. F. Burgess, Melrose Highlands, Mass.

Report of the Committee on National Museums, by J. J. Davis, Lafayette, Ind.

Report of Co-ordinating Committee on Program, by Alvah Peterson, Columbus, Ohio.

Report of Committee to Formulate Plans for Investigation of the Codling Moth from Biologic and Control Standpoints, by A. L. Quaintance, Washington, D. C.

Report of Committee on Research Work on the Control of the European Corn Borer, by G. A. Dean, Manhattan, Kansas.

Report of Committee on Recommendations to Secretary of Agriculture with reference to Needs for Foreign Stations to Study Insect Pests, Plant and Animal Diseases Introduced or likely to be Introduced, by Herbert Osborn, Columbus, Ohio.

Report of Committee on Training of Entomologists, by C. J. Drake, Ames, Iowa.

Report of the sub-committee on Entomological Exhibits for the Chicago Century of Progress Exposition, by W. P. Flint, Urbana, Ill.

Appointment of Committees.

Miscellaneous Business.

New Business.

Annual Address of the President, Franklin Sherman, Clemson College, S. C.

1. Census Taking in Entomology.

Discussion of Presidential Address.

READING OF PAPERS

Insects Affecting Greenhouse Plants

2. Red Spider Control in Greenhouses. (5 min.) C. C. Compton, Urbana, Ill.

3. The Effect of Temperature on Feeding and Development of the Greenhouse Leaftyer, *Phlyctaenia ferrugalis* Hb. (5 min.) (Lantern) G. A. Filinger, Wooster, Ohio.

A discussion of the amount of food eaten by greenhouse leaftyer larvae and the amount of time required to mature the larvae at different temperatures.

INSECTS AFFECTING ANIMALS

4. Nicotine in the Control of Ecto-parasites of Poultry. (5 min.) F. C. Bishopp and R. D. Wagner, Washington, D. C.

The results are presented of experiments with nicotine sulphate and free nicotine in the control of poultry parasites, particularly lice and mites.

Program

Wednesday Afternoon Session, December 31, 1:30; Room 24, Electricity Building, Case School of Applied Science.

READING OF PAPERS

INSECTS AFFECTING DECIDUOUS FRUITS.

5. Notes on the European Hornet. (3 min.) (Lantern) E. N. Cory, College Park, Md.

Occurrence, injuries to shrubs and fruit, nesting habits, population and proportion of castes.

6. The Cherry Case Bearer, *Coleophora pruniella* in Michigan (5 min.) Ray Huston, East Lansing, Mich.

A survey of the present distribution and abundance of this insect with data upon damage caused by it.

7. Control of the Cherry Case Bearer, *Coleophora pruniella* Clem., by Oil Sprays. (5 min.) (Lantern) A. A. Granovsky, St. Paul, Minn.

The lubricating oil cold mix emulsion gave the best results.

8. A Preliminary Report on Large Scale Bait Trapping of the Oriental Fruit Moth in Indiana and Georgia. (5 min.) W. P. Yetter, Jr., Vincennes, Ind., and L. F. Steiner, Cornelia, Ga.

A brief account of the first year's work of the large scale bait trapping experiments being conducted at Vincennes, Indiana and Cornelia, Georgia.

9. Results of Spraying and Dusting Experiments with the Control of the Curculio Attacking Peaches during the 1930 Season. (5 min.) O. I. Snapp, Fort Valley, Ga.

Comparative effectiveness of dusts carrying 5 and 10 per cent lead arsenate and the standard lead arsenate spray, and the value of adding fish oil to the sprays and of an application of lead arsenate when the buds are pink.

10. The Broods of the Plum Curculio, *Conotrachelus nenuphar* Herbst., in Delaware. A Preliminary Report. (5 min.) (Lantern) L. A. Stearns, Newark, Del.

Reports data obtained in a preliminary study of one-brooded and two-brooded curculio in Delaware.

11. Relation of Environment on Pear Psylla Infestation. (5 min.) (Lantern) F. Z. Hartzell and F. L. Gambrell, Geneva, N. Y.

Susceptibility of orchards to intensity of pear psylla attack has been found to be associated with variation in the environment under New York conditions. Suggestions are offered for modifying surroundings to lessen the injury by this insect.

12. Notes on Pear Psylla Control. (5 min.) (Lantern) F. Z. Hartzell, Geneva, N. Y.

Use of dormant oil sprays and summer oil treatments are discussed, with notes on material, time of application and effect on insects and trees. Some attention will be given to modifications in treatments with other insecticides.

13. Controlling Fruit Tree Leaf Roller with Oil Sprays. (5 min.) G. S. Tolles, East Lansing, Mich.

Results of laboratory and field tests of oil sprays in controlling the fruit tree leaf roller.

14. The Role of Yeast in Life History Studies of the Apple Maggot, *Rhagoletis pomonella* Walsh. (5 min.) C. L. Fluke Jr., and T. C. Allen, Madison, Wisc.

Rearing of the apple maggot was readily secured by feeding the adult flies a simple solution consisting of one to three per cent yeast in five per cent honey water. The flies lived for many days, readily mating and ovipositing in small cages in the field or laboratory.

15. Apple Maggot Investigations in 1930. (5 min.) (Lantern) P. J. Chapman, A. B. Burrell and F. G. Mundinger, Geneva, N. Y.

A general report of studies on the apple maggot in New York State in 1930, including notes on spray residue experiments.

16. Trends in Codling Moth Control in the Pacific Northwest. (5 min.) (Lantern) R. L. Webster and Anthony Spuler, Pullman, Washington.

Changes in spraying practice, particularly in orchard-growing sections of Washington, with special reference to improved spray equipment, summer oils, and the use of codling moth traps to determine spray dates.

17. Some Laboratory Reactions of Young Codling Moth Larvae. (5 min.) (Lantern) C. R. Cutright, Wooster, Ohio.

Data regarding the activities of young larvae at different temperatures on sprayed and unsprayed fruit.

18. Organic Solvents for Aiding the Removal of Spray Residue from Waxy or Oil Sprayed Fruit. (5 min.) (Lantern) R. H. Robinson, Corvallis, Oregon.

When certain organic solvents, such as alcohol, benzine, kerosene, gasoline, etc., or emulsions of some of these are added to the hydrochloric acid washing solution, waxy or oil sprayed fruit is more effectively cleaned.

19. A Study of Arsenical Residues on Apples in Pennsylvania with Respect to Efficient Spraying practices, II. (5 min.) H. E. Hodgkiss and D. E. Haley, State College, Pa.

A review of spray residue conditions during a season of minimum rainfall.

Insecticides

20. Preliminary Notes on the Chemistry of Codling Moth Baits. (5 min.) (Lantern) J. R. Eyer, State College, N. M.

21. The Radioactive Indicator Method of Estimating the Solubility of Acid Lead Arsenate within the Alimentary Tract of the Silkworm. (5 min.) (Lantern) F. L. Campbell and Chas. Lukens, Takoma Park, Md.

22. Copper Carbonate, Arsenate of Lead, and Other Compounds Used Against the Mediterranean Fruit Fly, *Ceratitis capitata* Wied., on Citrus in Florida. (5 min.) (Lantern) R. L. Miller, Orlando, Fla.

23. Problems in the Manufacture of Liquid Household Insecticides of the Petroleum Extract of Pyrethrum Type. (5 min.) Alfred Weed, New York, N. Y.

The manufacturer of these products is confronted with a number of perplexing questions which include: the concentration of the toxic constituents to be used, the use of Pyrethrum powder or concentrated extracts in preparing his product, the selection of satisfactory petroleum fractions and perfumes.

24. Studies on the Use of Extracts of Pyrethrum Flowers as Insecticides. (5 min.) H. G. Walker, Columbus, Ohio.

25. An Insecticidal Method for the Estimation of Kerosene Extracts of Pyrethrum. (5 min.) (Lantern) H. H. Richardson, Ames, Iowa.

Description of and results of the method are included. Statistical study of the results indicates that the speed of action is a diagnostic character of various strengths of pyrethrum extract.

26. A Preliminary Report on the Insecticidal Properties of Devil's Shoe String, *Cracea virginiana* L. (5 min.) V. A. Little, College Station, Texas.

This is a study of the comparative toxicity of this plant under laboratory and field conditions.

27. Studies on Hydrated Ferric Oxide as Corrective, Spreader and Sticker. (5 min.) (Lantern) J. M. Ginsburg, New Brunswick, N. J.

Experiments with Ferroskim, a mixture of ferric oxide and powdered skim milk, have shown that this product increases the adhesive and sticking properties of lead arsenate and nicotine tannate. It also acts as a corrective for arsenical injury on apple foliage.

28. The Function of Emulsifying and Spreading Agents in Oil Sprays. (5 min.) R. H. Smith, Riverside, California.

Results of research on the part Played by Emulsifers and Spreaders in the use of Oil Sprays.

29. Tests with Nicotine Activators. (5 min.) E. P. Felt and S. W. Bromley, Stamford, Conn.

Comparative results obtained in field tests with several types of nicotine activators.

30. Preliminary Report on Rotenone as an Insecticide. (5 min.) (Lantern) M. M. Darley, Columbus, Ohio.

Rotenone-Penetrol combinations compared with other standardized contact insecticides. Rotenone as a stomach poison.

Program

Thursday Morning Session, January 1, 10:00; Room 24, Electricity Building, Case School of Applied Science.

READING OF PAPERS

Insects Affecting Forest and Shade Trees.

31. An Experiment with Summer Oil for the Control of the European Elm Scale, *Gossyparia ulmi* L. (5 min.) C. R. Cleveland, Chicago, Ill.

Application of a summer or white oil emulsion in early July to nursery grown elms heavily infested by this insect produced highly effective control at 2% concentration of the emulsion. Data relative to influence of time and methods of application, insecticidal action of the oil, and tolerance of the trees to oil injury, are presented.

32. Preliminary Notes on the Biology and Control of the Pine Leaf Scale. (5 min.) A. G. Ruggles, St. Paul, Minn.

33. The Spruce Gall Aphis as a Nursery Problem. (5 min.) (Lantern) F. L. Gambrell, Geneva, N. Y.

A brief resume of the data obtained during the past 3 years relative to the life history and control of the spruce gall aphis are summarized together with information secured from the use of various insecticides as to their safety and relative efficiency.

34. Carpenter Worm Injury to Ash Trees in North Dakota. (5 min.) J. A. Munro, Fargo, N. D.

Observations made indicate that the Carpenter worm has confined its attack exclusively to ash trees in the Fargo vicinity. This paper includes notes on the life habits together with suggestions for control of the pest. The Arkansas king bird proved to be the most efficient natural control agent.

Insects Affecting Cereal and Forage Crops.

35. A Comparison of the Feeding Habits of Some Species of Empoasca. (5 min.) (Lantern) F. F. Smith and F. W. Poos, Rosslyn, Va.

A histological study of the areas on leaves, petioles and stems of plants exposed to *E. fabae* (Harris), and to several other species of Empoasca, has been made to determine the particular tissues fed upon by each species.

36. A Comparison of Oviposition and Nymphal Development of *Empoasca fabae* (Harris) on different Host Plants. (5 min.) (Lantern) F. W. Poos and F. F. Smith, Rossyln, Va.

Report on experiments to determine choice of oviposition and percentage of nymphs developing to adults on different species of plants. Some forage crop legumes were tested with special reference to their types of pubescence.

37. Seasonal History Studies on the European Corn Borer in Michigan. (5 min.) (Lantern) G. T. Bottger and V. F. Kent, U. S. Bureau of Entomology.

Results of observations conducted under both field and insectary conditions over a period of five years.

38. Some observations on the Planting Date of Corn in Relation to Corn Borer Population. (5 min.) G. A. Ficht, Lafayette, Ind.

Three year's observations on the effect of planting date of corn on borer population are given along with a discussion of some of the factors governing the differences in populations of the plantings.

39. Correlation between Corn Borer Survival and Maturity of Corn. (5 min.) (Lantern) E. G. Kelsheimer and J. B. Polivka, Wooster, Ohio.

Data presented show a significant correlation between borer survival and host development.

40. Migration and Dissemination of European Corn Borer Larvae. (5 min.) (Lantern) C. R. Neiswander and J. R. Savage, Wooster, Ohio.

This paper gives the results of experiments on the amount of distance of larval dissemination and on the period of migration.

41. Some Causes contributing to European Corn Borer Abundance. (5 min.) (Lantern) L. L. Huber and C. R. Neiswander, Wooster, Ohio.

This paper consists of a brief analysis of the major causes contributing to the reduction in European corn borer population in Ohio in 1930.

42. The Effects of Physiological Change in the Corn Plant on European Corn Borer Establishment. (5 min.) (Lantern) J. B. Polivka, Wooster, Ohio.

Data presented indicate that the reduction in corn borer infestation as a result of the use of insecticides is due in part to the disturbance of the physiology of the plant.

43. The Lethal Power of Certain Insecticides Tested in Michigan Against the European Corn Borer. (5 min.) (Lantern) F. L. Simanton, F. F. Dicke and G. T. Bottger, Monroe, Mich.

44. Notes on Parasitism and Infestation by *Pyrausta nubilalis* in Europe in 1929. (5 min.) H. L. Parker, A. M. Vance and H. D. Smith, Hyeres, France.

Condensed data on parasitism by zones and infestation in 1929 in Italy and France.

45. *Pyrausta nubilalis* Hubn. Handling of Single Generation Larvae to Supply Parasite Data. (5 min.) W. A. Baker and Ralph Mathes, Monroe, Mich.

A discussion of the effect of time of collection and relation of diapause and moisture requirements to laboratory handling of single generation European Corn Borer Larvae.

46. The Soy Bean Caterpillar in Louisiana. (5 min.) (Lantern) W. E. Hinds and B. A. Osterberger, Baton Rouge, La.

Outline of its occurrence, life history, control and natural enemies as found in 1930.

47. The Wheat Straw Worm, *Harmolita grandis* Riley, in Utah. (5 min.) G. F. Knowlton, Logan, Utah.

The wheat straw worm is generally distributed throughout northern Utah, and damage to irrigated and dry-farm wheat was apparent in many areas.

48. Anatomy of the Hessian Fly Larva. (5 min.) (Lantern) Leonard Haseman, Columbia, Mo.

49. Reaction of Sorghum Varieties and Hybrids to Chinch Bugs. (5 min.) (Lantern) R. H. Painter, Manhattan, Kansas.

Under chinch bug attack, sorghums vary greatly in percentage of plants killed and amount of injury. The resistance of certain varieties is inherited independent of desirable agronomic characters.

50. Grub Infestation as a possible Indication of Crop Selection by May bettles for Egg Laying. (3 min.) K. Koch and C. L. Fluke, Jr. Madison, Wisconsin.

Population studies of the white grub show that there are fewer grubs in certain legumes, indicating that adult beetles are plant selective in egg laying habits.

Program

Thursday Afternoon Session, January 1, 1:30; Room 24
Electricity Building, Case School of Applied Science.

Insects Affecting Household and Stored Grain

51. Paradichlorobenzene as a Fumigant for Clothes Moths. (5 min.) G. W. Herrick and G. H. Griswold, Ithaca, N. Y.

52. A Preliminary Report on the Effectiveness of Sodium Fluosilicate as Compared with Borax in Controlling the House Fly. (5 min.) (Lantern) S. Marcovitch and M. V. Anthony.

53. Protecting Stored Grain from Insects by the Use of Oils. (5 min.) (Lantern) W. P. Flint, Urbana, Ill.

Dipping or spraying corn with certain miscible oils and oil emulsions has protected such corn from insect injury when kept in storage where stored grain insects were excessively abundant. Tests are under way with other grains. Experiments reported extending over a three-year period.

Miscellaneous Papers

54. Various Types of Insect Olfactometers used in America and South Africa. (5 min.) (Lantern) N. E. McIndoo, Takoma Park, Washington, D. C.

Three types of olfactometers will be briefly described and illustrated with lantern slides

55. A New Automatic Insect Trap for the Study of Insect Dispersion and Flight Association. (5 min.) (Lantern) R. A. Fulton and J. C. Chamberlin, Twin Falls, Utah.

An Insect trap which automatically receives and retains the insects borne by a representative moving current of air is described, and its application to studies of insect dispersal and flight associations, with especial reference to *Eutettix tenellus* Baker, is discussed.

56. The Differential Between the Effect of Radio Waves on Insects and on Plants. (5 min.) (Lantern) T. J. Headlee, New Brunswick, N. J.

There seems to exist a satisfactory differential between the effect of radio waves on insects and the effect of these same waves on certain plant hosts.

57. Developing Resistance or Tolerance to Insect Attack. (5 min.) E. P. Felt and S. W. Bromley, Stamford, Conn.

A discussion of the effect of plant vigor upon resistance or tolerance to insect attack.

58. A Comparison Between the Temperature and Humidity within Common Types of Insect Rearing cages and the Outside. (5 min.) (Lantern) R. C. Smith, Manhattan, Kansas.

A series of studies to see whether a hygrothermograph in an insectary or in the field beside cages indicated the temperature-humidity conditions in the cages.

59. An Incubator Room. (5 min.) (Lantern) W. A. Baker and K. D. Arbuthnot, Monroe, Michigan.

Details of construction and installation of equipment in an insect incubation chamber utilized in rearing European corn borer parasites.

60. The Present Status of the Introduced Parasites of *Popillia japonica* New. (5 min.) J. L. King, Moorestown, N. J.

61. The Application of Artificially Delaying *Microgaster tibialis* Nees, Development to Emergence and Liberation. (5 min.) W. A. Baker and K. D. Arbuthnot, Monroe, Michigan.

Discussion of results obtained by use of cold storage and its application to handling of adults for liberation, also results of some other methods which have been tried.

62. Artificial Rearing and Colonization of *Trichogramma minutum*. (5 min.) D. F. Farlinger and C. H. Alden, Cornelia, Ga.

Two years results on rearing and colonization of *T. minutum* on peach, apple and pecan insects of Georgia.

63. New Methods for Liberating *Trichogramma minutum* in Field and Orchard. (5 min.) A. W. Morrill, Los Angeles, Calif.

Methods devised by the author to facilitate the successful liberation of the parasite, and to overcome certain difficulties encountered in large scale operations are described.

64. Some Notes on the Refrigeration of Insect Eggs Parasitized by *Trichogramma minutum*. (5 min.) A. Peterson, Columbus, Ohio.

Some information on the species of insect eggs and the temperature and moisture required to carry *Trichogramma minutum* in a living state for several months.

65. A Simple Filing System for a State Insect Pest Survey. (5 min.) (Lantern) J. A. Hyslop, Washington, D. C.

66. The Potato Leaf Hopper and its Close Relatives of Empoasca occurring on Truck Crops in the United States. (5 min.) (Lantern) D. M. DeLong, Columbus, Ohio.

A brief discussion of the species concerned and the areas of occurrence in the United States.

67. A Comparison of Mercury Compounds in Root Maggot Control. (5 min.) H. Glasgow, Geneva, N. Y.

68. A Preliminary Report on the Lima Bean Pod Borer and other Legume pod Borers in Porto Rico. (5 min.) M. D. Leonard and A. S. Mills, Rio Piedras, Porto Rico.

Preliminary observations on the distribution, life history economic importance and food plants of *Maruca testulalis* Geyer. Notes are also given on several other lepidopterous pod borers of legumes and on their parasites.

69. Studies of *Eutettix tenellus* Baker in 1930 in Southern Idaho. (5 min.) (Lantern) P. N. Annand, J. C. Chamberlin, C. F. Henderson and H. A. Waters, Twin Falls, Idaho.

A review of the 1930 dispersal and prediction of *E. tenellus* attack is given together with data relative to direction, source, and length of time involved in the flight.

70. Effect of Protective Covering Upon the Overwintering of Eggs of the Pea Aphid *Illinoia pisi* Kalt. (5 min.) T. E. Bronson, Madison, Wisconsin.

Eggs were placed in small mesh cages and given various degrees of protection in the field. Temperature conditions were recorded.

71. *Pangaeus uhleri* Sign., A Pest of Spinach. (5 min.) G. E. Gould, Norfolk, Va.

A Burrower-bug, *Pangaeus uhleri* Sign., was observed attacking spinach just as the seedlings were pushing through the ground. Although the infestation was confined to a few fields, the seriousness of the damage this year shows that the insect is sometimes of economic importance. Several unusual habits of the insect are recorded.

72. Observations on the Wintering habits of the Striped Cucumber Beetle. (5 min.) Leonard Haseman, Columbia, Mo.

Program

Thursday Evening Session, January 1, 8:00; Room 24, Electricity Building, Case School of Applied Science.

Section of Extension

C. R. Crosby, *Chairman* T. H. Parks, *Secretary*

1. Extension Entomology. C. R. Crosby, Ithaca, N. Y.
2. Ox Warble Control in Northern Illinois. C. C. Compton, Urbana, Ill.

3. Directing Red Spider Control Through the Use of Special Tags on Nursery Stock. E. L. Chambers, Madison, Wis.

4. Outbreak of Corn Earworm in Missouri. Leonard Haseman, Columbia, Mo.

5. Developments of Argentine Ant Control and Eradication in Mississippi. R. W. Harned, Agricultural College, Miss.

6. Climatic Conditions and Their Effect upon the Sugar Cane Borer Population in Louisiana in 1930. W. E. Hinds and B. A. Osterberger, Baton Rouge, La.

SYMPOSIUM

Effect of the 1930 Drought Upon Insect Population.

Cereal Crop Insects, W. H. Larrimer, Washington, D. C., W. P. Flint, Urbana, Ill.

Forage Crop Insects, Herbert Osborn, Columbus, Ohio, J. J. Davis, Lafayette, Ind.

Forest and Shade Tree Insects, J. S. Houser, Wooster, Ohio.

Fruit Insects, W. J. Schoene, Blacksburg, Va.

Truck Crop Insects, P. D. Sanders, College Park, Md., Neale Howard, Columbus, Ohio.

General Discussion.

Selection of Officers.

Program

Friday Morning Session, January 2, 10:00; Room 24, Electricity Building, Case School of Applied Science.

FINAL BUSINESS

Report of Committee on Resolutions.

Report of Committee on Membership.

Reports of other committees.

Nomination of Journal officers by Advisory committee.

Report of Committee on Nominations.

Election of Officers.

Miscellaneous business.

Fixing the time and place of next meeting.

Final adjournment.

FRANKLIN SHERMAN, *President*,
Clemson College, S. C.

A. F. BURGESS, *Secretary*,
Melrose Highlands, Mass.

JOURNAL
OF
ECONOMIC ENTOMOLOGY
OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Vol. 23 FEBRUARY, 1930 No. 1

Proceedings of the Forty-Second Annual Meeting of the American Association of Economic Entomologists

The 42nd annual meeting of the American Association of Economic Entomologists was held at the Savery Hotel, Des Moines, Iowa, December 30, 1929 to January 1, 1930.

The Section of Plant Quarantine and Inspection convened at 9:50 A. M., December 30 and adjourned the same day at 6:10 P. M. Chairman F. N. Wallace, Indianapolis, Indiana, presided and S. B. Fracker, Washington, D. C., was the Secretary. In his address as Chairman, Mr. Wallace discussed the training and temperament required for successful plant quarantine enforcement. The status and importance of the Mediterranean fruit fly eradication campaign in Florida were described by L. A. Strong and Wilmon Newell. Other phases of Federal quarantine activities were discussed in papers by L. B. Smith, W. E. Fleming, C. H. Hadley, S. B. Fracker, R. A. Sheals and L. B. Hutchins. Similar work in the various states was discussed by L. M. Gates, E. L. Chambers, K. C. Sullivan, B. F. Boillot, R. W. Harned and E. N. Cory. Reports of National and Regional Plant Boards were given.

E. N. Cory, College Park, Maryland, was elected Chairman for the ensuing year and S. B. Fracker continues as Secretary.

The Section of Extension (J. A. Hyslop, Washington, D. C., Chairman; G. F. MacLeod, Ithaca, N. Y., Secretary) met on the afternoon of December 30. J. A. Hyslop presented a paper on the "Work of the Insect Pest Survey and Insect Conditions during 1929." G. A. Dean presented a paper on "Factors that Determine the Selection of Control Measures." These two papers were followed by reports on extension work in Iowa, by F. D. Butcher, in Ohio, by T. H. Parks, in New York by C. R. Crosby, in Illinois by J. H. Bigger, in Missouri by L. Haseman, in Nebraska by O. S. Bare and in Colorado by G. M. List.

C. R. Crosby, Ithaca, N. Y., was elected Chairman for 1930 and T. H. Parks, Columbus, Ohio, Secretary.

The Section of Apiculture (G. M. Bentley, Knoxville, Tenn., Chairman; E. N. Cory, College Park, Maryland, Secretary) was addressed

by the Chairman and had a program of ten papers dealing with various phases of apiculture. R. L. Parker, Manhattan, Kansas, is Chairman for 1930 and F. B. Paddock, Ames, Iowa, Secretary.

The Crop Protection Institute held a dinner and meeting Monday evening, December 30.

The program of the main Association opened Tuesday morning with the usual business session, after which President T. J. Headlee gave his address "Some Tendencies in Modern Economic Entomological Research." It was brought out in the address, and in the discussion that followed it, that the entomologist in his studies finds himself confronted with problems that have to do with many branches of science, and that in order to satisfactorily solve these problems he must obtain the assistance of workers in these other fields. Reading of papers followed. Fifty-seven papers were on the program. Of these, four papers dealt with insects affecting forest and shade trees, eighteen with insects affecting deciduous fruits, thirteen with insects affecting cereal, forage and field crops, one with insects affecting animals, five with insecticides and appliances, five with insects affecting truck crops, five with insects affecting the household and stored products and six were classed as miscellaneous. Of the papers having to do with insects affecting deciduous fruits, six dealt with the codling moth and five with the oriental fruit moth and various measures for the control of both pests were discussed. Papers relative to new pests of apple, cherry and raspberries were also presented. The papers on insects affecting cereal, forage and field crops dealt with several insects. Three had to do with the biology of the hessian fly and others had to do with the corn borer, the pink bollworm, wireworms and certain insects attacking clover and alfalfa. The papers dealing with insects affecting truck crops had to do with the Mexican bean beetle, the potato leaf hopper and the onion maggot while those relating to insects affecting the household and stored products covered the control of insect pests of upholstered furniture, storage of furs and other garments, the pea weevil problem and methods of protecting seed. Papers having to do with insecticides dealt with lead arsenate and sodium fluosilicate, arsenical substitutes, oil sprays and insect respiration in relation to the toxicity of contact insecticides. Other papers were presented that treated of parasites, insect association studies and experimental plots.

The meeting ended with a final business session with 142 members being admitted to the Association. Franklin Sherman, Clemson College, S. C., was elected President, J. S. Houser, Wooster, Ohio, First Vice-President and A. F. Burgess, Melrose, Mass., Secretary.

On the Sunday preceding their meeting many of the members went to the Iowa State College at Ames. Besides visiting the Department of Zoology and Entomology of the College the members attended a dinner at the Memorial Union and later listened to an address by Dr.Herbert Osborn of Ohio State University concerning the early history of entomology in the central states. The entomologists' dinner was held at the Hotel Savery, Des Moines,Tuesday night, with an attendance of 181. Those present very much enjoyed the musical entertainment and a humorous dialogue having to do with entomology and entomologists.

The business proceedings form Part I of this report and the addresses. papers and discussions form Part II.

PART I. BUSINESS PROCEEDINGS

The meeting was called to order by President T. J. Headlee at 9:50 A. M., December 31. Approximately 200 members and visitors attended the sessions.

(A dagger (†) before the name of a member in the printed membership list indicates that he signed the register as attending the Des Moines meeting.)

PRESIDENT T. J. HEADLEE: Gentlemen, the 42nd annual meeting of the Association is now open for business.

The first item is the report of the Secretary.

REPORT OF THE SECRETARY

Membership in the Association at the time of the New York meeting, together with the election of new members, resignations, those dropped for non-payment of dues and losses by death since, is summarized as follows:

	Active	*Associate*	*Foreign*
Total membership, beginning of New York meeting	444	446	45
Transferred from Associate to Active membership, New York meeting	48	–48	
	492	398	45
Members elected, New York meeting		102	5
Re-instatements, New York meeting		5	
Resignations, New York meeting	–1	–6	
	491	499	50
Dropped for non-payment of dues, 1929	—	–30	
Deaths recorded since New York meeting	–1	–1	
Total membership, beginning of Des Moines meeting	490	468	50
Grand Total 1008			
Net gain 73			

J. W. McColloch, an active member of the Association, died November 11, 1929, at Manhattan, Kansas. He was an entomologist of wide experience in both teaching and research. He had been connected with the Experiment Station at Manhattan and the Kansas Agricultural College since his graduation there in 1912. He had published several useful papers on his findings in connection with insects affecting cereal crops.

C. W. de Rekenski, an associate member, who became enrolled in 1929, died in April, 1929. No further details known.

The 14th annual meeting of the Pacific Slope Branch was held at the University of California, Berkeley, June 20 and 21. The total attendance was 88 members and visitors.

The Cotton States Branch held its 4th annual meeting at the Rice Institute, Houston, Texas, February 6 and 7, at the same time and place as the Southern Agricultural Workers. The total attendance of 71 exceeded that of any other meeting. The program required the time of two long sessions.

The Eastern Branch held its second annual meeting in New York City, at the American Museum of Natural History, November 21 and 22. It proved to be very interesting, with a full program of about 45 papers and about 100 members and visitors were present.

Journal of Economic Entomology

Volume 22, of the Journal of Economic Entomology has just been completed and contains 1019 printed pages, the largest volume in its history and the first year that the pagination has exceeded 1000. For the first 16 years the Journal contained an average of 515 pages; during the six years of 1924 to 1929 inclusive, the pagination has gained an average of 368 or 71 per cent over the previous 16 years treated as a whole.

This gain in size of the Journal has been accomplished during the six-year period treated here without increasing the subscription price. This has been made possible by the hearty co-operation of the members subscribing liberally to the publication and the strong and increasing demand in subscriptions from foreign countries.

Complete sets of the Journal are still available, excepting Volume 1 (No. 2 of which is out of print). It was necessary to raise the price of some of the volumes during the current year—Volume 15 selling for $4; Volumes 8 and 11 for $4.50 each; Volumes 18 and 19 for $5 each and Volume 12 for $6.

It may be necessary to further increase the price of certain volumes next year as the supply decreases. Members desiring to complete their sets should take advantage of the present rates before the supply becomes further exhausted.

The following table shows the total domestic and foreign subscribers in 1913, 1923, 1928 and 1929:

	1913	1923	1928	1929
Alabama	3	9	10	8
Arizona	7	8	20	17
Arkansas	2	4	8	9
California	34	67	127	133
Colorado	7	12	14	15
Connecticut	10	15	19	26
Delaware	3	3	6	8
District of Columbia	50	55	60	60
Florida	7	15	26	30

	1913	1923	1928	1929
Georgia	6	10	14	15
Idaho	2	6	7	8
Illinois	30	31	34	31
Indiana	16	15	24	26
Iowa	5	12	18	21
Kansas	16	16	26	24
Kentucky	4	5	4	8
Louisiana	12	17	28	30
Maine	5	7	11	11
Maryland	11	14	14	22
Massachusetts	48	76	71	68
Michigan	15	10	24	27
Minnesota	10	14	12	13
Mississippi	4	22	37	35
Missouri	8	12	13	15
Montana	5	7	9	7
Nebraska	3	3	8	7
Nevada	1	2	3	3
New Hampshire	4	9	9	8
New Jersey	14	22	44	38
New Mexico	3	3	4	3
New York	52	69	87	88
North Carolina	6	8	19	20
North Dakota	0	1	1	2
Ohio	22	34	57	65
Oklahoma	2	5	6	6
Oregon	10	12	17	17
Pennsylvania	18	38	43	41
Rhode Island	3	7	4	4
South Carolina	4	2	11	11
South Dakota	1	2	2	2
Tennessee	6	11	19	18
Texas	16	21	46	50
Utah	8	9	17	17
Vermont	1	1	2	2
Virginia	7	16	18	22
Washington	8	8	19	20
West Virginia	5	5	5	5
Wisconsin	6	13	17	16
Wyoming	0	2	4	3
Total for U. S.	520	765	1098	1135
U. S. Insular Possessions and Cuba	26			
Hawaii		11	10	12
Panama and Virgin Island		2	2	1
Philippines		5	5	6
Porto Rico and Cuba		7	14	13
Canada	27	47	57	56
Foreign	132	183	317	346
GRAND TOTAL	705	1020	1503	1569

The above table, together with those published in previous years, shows the following gains:

One hundred fifteen subscriptions in 1925 over 1924; 98 subscriptions in 1926 over 1925; 77 subscriptions in 1927 over 1926; 89 subscriptions in 1928 over 1927; 63 subscriptions in 1929 over 1928.

INDEX I AND II TO THE LITERATURE OF AMERICAN ECONOMIC ENTOMOLOGY

The accounts of these two volumes have been combined since 1925, at which time their indebtedness to the Association was paid off. The sales of these two publications during the year amounted to $203.29, which is slightly less than the receipts of 1928. There are on hand at the present time about 440 copies of Index I and about 460 of II. From this combined account, $675 was loaned in 1925 for the publication of Index III. There remains at the end of this fiscal year $125 indebtedness to Indices I and II. (See financial statement.)

INDEX III TO THE LITERATURE OF AMERICAN ECONOMIC ENTOMOLOGY

In the Secretary's report for 1925 it was stated that $1675 was borrowed from the Association, JOURNAL and Indices I and II accounts to assist in financing the publication of Index III. This indebtedness has been paid back, with the exception of $125 still due Index I and II accounts and $500 to the JOURNAL account, making a total of $625 indebtedness.

The amount received from sales of this number in 1927 was $205.15, in 1928 $195.50 and $148.26 in 1929. There are about 630 copies still on hand of this volume.

It has been stated that there are about 440 copies of Index I, published in 1917; 460 of Index II, published in 1920 and 630 of III, published in 1925. It would appear that the stock on hand slightly exceeds the demand for these volumes and this being the case, I would recommend that a smaller edition be printed of Index IV, providing that number is to be published in 1930. It would seem as though 800 copies would be a sufficient number to satisfy the demand for quite a number of years.

PERMANENT FUND

At the Philadelphia meeting in 1926, the Association voted that the interest on all deposits be transferred annually to the credit of the Permanent Fund. As a result, in 1928 $475.99 was so transferred and $517.75 in 1929 (The latter figure is exclusive of $63.75 interest on Liberty Bonds. The 1928 figure includes such interest.)

The Executive Committee this year approved the transfer to the Permanent Fund of $500 from the Association account and $200 from the JOURNAL account.

No application for life membership was received in 1929.

ASSOCIATION STATEMENT

Balance in Treasury, November 26, 1928		$1057.31
Amount received from dues and separates		1529.00
Amount received from bank interest		9.00
Paid—Stenographic Report, 1928	$ 94.92	
Postage	64.62	
Programs and notices	13.57	
Supplies and stationery	33.54	
Transferred to Permanent Fund	500.00	
Transfer of interest to Permanent Fund	9.00	
Expenses of Pacific Slope Branch	18.65	
Expenses of Cotton States Branch	23.73	
Returned checks	9.60	
Secretary	100.00	
Clerical work, Secretary's office	65.00	
Refunds on Applications for Membership	6.00	
Mimeographing	3.75	
Miscellaneous Expenses, Secretary's office	39.24	
	$ 981.62	
Balance, November 30, 1929	1613.69	
	$2595.31	$2595.31

Balance deposited in First National Bank, Malden, Mass.

Journal Statement

Balance in Treasury, November 26, 1928		$ 4072.23
Amount received from subscriptions, reprints, advertising, etc.		6335.60
Amount received from bank interest.		12.00
Paid—Postage	$ 336.10	
Printing	4171.37	
Supplies and stationery	31.81	
Half-tones and engravings	461.39	
Telegraph, Express and Freight	3.97	
Editor	200.00	
Clerical work, Editor's Office	190.00	
Clerical work, Business Manager's Office	135.00	
Business Manager	100.00	
Transferred to Permanent Fund	200.00	
Transfer of interest to Permanent Fund	12.00	
Returned checks	14.40	
Miscellaneous Expenses, Business Manager's Office	14.50	
Refund on Applications for Membership	10.00	
Reprints	164.18	
	$6044.72	
Balance, November 30, 1929	4375.11	
	$10419.83	$10419.83
Balance deposited in First National Bank, Malden, Mass.		$ 2851.35
Balance deposited in Melrose Trust, Melrose, Mass.		1523.76
		$ 4375.11

Index I and II Statement

Balance in Treasury, November 26, 1928		$1198.91
Received from Sales		203.29
Transferred from Index III.		150.00
Interest		5.60
Paid—Postage	$ 5.76	
Transfer of interest to Permanent Fund	5.60	
	$ 11.36	
Balance, November 30, 1929	$1546.44	
	$1557.80	$1557.80
Balance deposited in First National Bank, Malden, Mass.		$1546.44

Index III Statement

Balance, in Treasury, November 26, 1928		$ 12.40
Received from Sales		148.26
Paid—Postage	$ 3.81	
Transferred to Index I and II account	150.00	
	$ 153.81	
Balance, November 30, 1929	$ 6.85	
	$ 160.66	$ 160.66
Balance deposited in First National Bank, Malden, Mass.		$ 6.85

Indebtedness of Index III

Index III owes Index I and II	$ 125.00
Index III owes Journal	500.00
Total Indebtedness	$ 625.00

PERMANENT FUND

Balance, Melrose Savings Bank, November 26, 1928	$ 5315.04
Interest on Deposits, Melrose Savings Bank	237.20
Interest on Liberty Bonds	63.75
1929 Interest from First National Bank, Malden, Mass (Accounts: Indices I and II, Index III, JOURNAL, Assoc.)	26.60
1929 Interest from Melrose Trust Company, Melrose, Mass (JOURNAL account)	61.84
Interest, Certificate of Deposit, First National Bank, Malden (Accounts: Indices I and II, JOURNAL, Association)	192.11
Paid into Permanent Fund from Association	500.00
Paid into Permanent Fund from JOURNAL	200.00
4¼% Liberty Bonds	1500.00
GRAND TOTAL	$ 8096.54

SUMMARY

Balance in Indices I and II Account, November 30, 1929	$ 1546.44
Balance in Index III Account, November 30, 1929	6.85
Balance in JOURNAL account	4375.11
Balance in Association account	1613.69
	$ 7542.09

Respectfully submitted,
C. W. COLLINS, *Secretary*

MR. W. B. HERMS: I have just heard the report of the Secretary. Before anything else is done by this Association, I move that the Secretary be instructed to send a telegraphic message of greetings and best wishes from this Association to Mr. Collins.

The motion was adopted.

PRESIDENT T. J. HEADLEE: Before I ask for the disposition of the report of the Secretary, I should like to have the report of the Committee on Audit.

REPORT OF THE AUDITING COMMITTEE

We have examined the books of the Secretary-Treasurer and find them to be correct insofar as the entries are concerned. To make a final audit, complete documentary evidence is necessary and this is not available to us.

We hereby recommend that the Association have a commercial auditing firm review the books each year in place of a committee of members of the Association.

LOREN B. SMITH
T. H. FRISON

Voted that the report be accepted and adopted; after which it was voted that the report of the Secretary be adopted.

Vice-President F. N. Wallace assumed the chair.

VICE-PRESIDENT F. N. WALLACE: We will next have the report of the Executive Committee by President T. J. Headlee.

REPORT OF THE EXECUTIVE COMMITTEE

The business transacted by your executive committee previous to gathering for the present meeting covered the following points: (1) the appointment of an entomological member of the National Research Council's Committee for the Chicago World's Exhibition; (2) the local arrangements for the present annual meeting; (3) the appointment of a Secretary-Treasurer pro tem for the present meeting. Mr. W. P. Flint was selected as the committee man and told to associate with himself such workers as he saw fit and to do and perform according to his best judgment. Dr. Chas. H. Richardson was selected as chairman of the committee on arrangements and he was asked to associate with himself such persons as he saw fit and to make such local arrangements as in his judgment would be most likely to promote a meeting satisfactory to the membership. At the request of Secretary-Treasurer C. W. Collins, whose serious illness would surely prevent him from attending this meeting, T. H. Jones of Melrose Highlands, Mass., was selected to serve in Mr. Collins' place for the present meeting.

Two meetings of your executive committee have been held since the gathering of entomologists for this meeting began and the following business has been transacted.

A communication from C. W. Stiles regarding proposed amendments to international rules of zoological nomenclature was referred to your standing committee on nomenclature for consideration and report.

The duty of recommending certain papers from this meeting to the A. A. A. S. committee on award has been assumed by your executive committee. It is planned that each member shall at the immediate close of the sessions submit his choice and that the paper receiving the most approval shall be forwarded to the committee on award.

The question of program congestion was considered but it was decided that in view of the smaller number of papers this year and the possible effect of branch meetings upon the number of papers in future years, no recommendation for change calculated to relieve congestion should be made at this time. Your committee decided that next year's program could be materially improved by securing an address from a man in one of the most prominent economic entomological fields of endeavor and it recommends that Dr. W. R. Thompson of Great Britain be invited to present a paper before this association on the subject of biological control.

After study of the fiscal matters of your association, your committee wishes to recommend the practice of having the accounts passed on previous to the meeting by a properly qualified auditor. The sums involved and the risk of transporting securities are more than sufficient to justify this action.

Your committee has examined and approved the articles of agreement covering the organization of the Eastern Branch of the American Association of Economic Entomologists.

Your committee has considered the request of the Eastern Branch for publication of its proceedings in the Journal of Economic Entomology and wishes to recommend that such publication be afforded, providing the said branch will bear the cost.

Your committee has given careful study to a letter from Professor Ferris of Leland Stanford University, presenting his evidence that there is danger of free speech in quarantine matters being curtailed. Your committee's study of this claim and the submitted evidence underlying it lead to the conclusion that the evidence cannot be properly construed as supporting the claim. Your committee believes in the free-

dom of speech in these and other matters of public interest but cannot see that it is being curtailed or threatened with curtailment in this instance.

Respectfully submitted,

T. H. JONES, *Sec. Pro Tem*
R. W. HARNED
L. S. MCLAINE
W. B. HERMS
W. P. FLINT
P. J. PARROTT
T. J. HEADLEE

Voted that the report be adopted.

President T. J. Headlee resumed the chair.

PRESIDENT T. J. HEADLEE: The next item of business on our program is the report of the Representative to the National Research Council.

No report was given.

PRESIDENT T. J. HEADLEE: The next item of business is the report of the Governors of the Crop Protection Institute.

REPORT OF THE BOARD OF GOVERNORS OF THE CROP PROTECTION INSTITUTE

By W. C. O'KANE

In the course of the year 1929, the Institute has directed 17 Research projects. Of these, nine are new undertakings, begun at various times in the course of the year, while eight are continuations of projects begun at earlier dates.

The studies undertaken as new enterprises include the following:

Control of brown patch of golf greens.
Development of a new insecticide for mosquitoes, flies and the like.
Incorporation of a fungicide in oxidized oil.
Methods of extraction of pyrethrum.
Experiments with naphthalene derivatives.
A study of cocoanut oil emulsions.
Development of a special adhesive tape for use in grafting fruit stocks.
A study of the insecticidal and fungicidal possibilities of some new compounds originating in the tanning industry.
Incorporation of fungicides in saturated oils.

The projects continued from earlier dates include the following:

Experiments in plant introduction.
Research in alkaloids as insecticides.
A study of repellents.
Further work on a summer oil spray.
Development of a new type of sulphur.
Further research in oxidized oils as insecticides.
Continuation of research in derivatives of furfural.
Studies of shale oils.

The geographical distribution of these research projects includes 13 states, ranging form Massachusetts and New Hampshire in the east, to Florida in the South, and to Kansas in the west.

The staff of research men has varied from 16 to 20, the greater part of whom are on a full-time basis. As in prior years, some of these men have been permitted to take one subject at a time toward completion of their doctorate. Usually the men who are doing this are able to utilize some part of their investigational work as the basis for their doctorate dissertation.

The plan of operation of the Institute remains the same as in former years. Each project is handled as a separate enterprise with its own supervising committee, selected from the ranks of entomologists, plant pathologists, and chemists. The coöperation of experiment stations continues to be a vital factor in the success of the Institute's work.

Voted that the report be adopted.

PRESIDENT T. J. HEADLEE: The next item of business is the report of the Scientific Trustee, Tropical Plant Research Foundation.

REPORT OF THE SCIENTIFIC TRUSTEE, TROPICAL PLANT RESEARCH FOUNDATION

The activities in entomological lines under direction of the Foundation have been confined, as heretofore, for the most part to the station established at Baraguá, with Professor D. L. Van Dine as the local director. The studies have continued on the sugar cane insects and papers have been published giving the results of studies of these insects. It is stated by Mr. Van Dine that there is a plan to shift the emphasis in entomological work so that more attention may be given to the soil insects which affect sugar cane.

Publications relating to entomology include a bulletin entitled "A Survey of the Investigation of the Sugar-Cane Moth Borer in Cuba," by H. K. Plank, "The Parasites of Sugar-cane Moth Borer in Cuba" by D. L. Van Dine, "Natural Enemies of the Sugar Cane Moth Borer in Cuba" by H. K. Plank, published in the Annals of the Entomological Society of America, and two articles by H. K. Plank, "Nematodes Parasitic on *Diatraea saccharalis* Fabricius in Cuba" and "Fungi Attacking *Diatraea saccharalis* Fabricius in Cuba," both published in the JOURNAL OF ECONOMIC ENTOMOLOGY.

There has been considerable change in the personnel of the station staff, Mr. C. F. Stahl having resigned to take up work with the U. S. Bureau of Entomology. Mr. Stahl's place has been filled by the appointment of Mr. U. C. Loftin to the position of Chief Entomologist, effective Nov. 1, 1929. Mr. H. K. Plank has been promoted to the position of Entomologist. Mr. Luis C. Scaramuzza, Assistant Entomologist, has been transferred from Baraguá to Jaronú to continue the biological studies on the parasites of the moth stalkborer. Mr. L. Dean Christenson, recently in the U. S. Bureau of Entomology under Dr. B. R. Coad, has been appointed to the position of Assistant in Entomology, effective Oct. 20, 1929, to be stationed in Baraguá.

An interesting development concerning the activities of the Foundation may be mentioned in connection with a request from Colombia for the Foundation to suggest an entomological teacher for the Agricultural School at Medellin. After consideration of a number of candidates the Foundation recommended Doctor C. H. Ballou, formerly with the Experiment Station of Cuba and therefore quite familiar with the Spanish language, recently with the Bureau of Entomology at Moorestown, New Jersey, and his appointment came in due course and he is doubtless now in charge of the work in Colombia. This case emphasizes what has already been men-

tioned, that the openings for qualified entomologists in tropical work seem to be increasing and it would seem desirable that more of our young Entomologists should look to this field as a possibility and qualify themselves in the use of Spanish as a quite necessary feature of their work.

My two months sojourn in Porto Rico during the past winter has served to increase my interest in tropical studies and appreciation of the immense field of entomological work in the tropical countries of America.

HERBERT OSBORN

Voted that the report be adopted.

PRESIDENT T. J. HEADLEE: The next item of business is the report of the Representative on the Council of the Union of Biological Societies, by Dr. A. L. Quaintance.

No report was read but Dr. Quaintance requested that the following report be inserted in the business proceedings.

REPORT ON BIOLOGICAL ABSTRACTS TO THE SOCIETY REPRESENTATIVES ON THE COUNCIL OF THE UNION OF AMERICAN BIOLOGICAL SOCIETIES

Dr. C. E. McClung, President of the Union of American Biological Societies, informs me that it will not be practicable to hold a meeting of the Council of the Union at the Des Moines meeting. Since Biological Abstracts is a creature of our national biological societies, he therefore suggests that I submit a brief report to the Society representatives on the Council to be brought to the attention of their respective societies as opportunity may present itself at the coming meetings.

The year has been one of substantial progress. Thirty-six thousand abstracts have been published in 1929 (45,000 sent to press), and with the January, 1930, issue the regular monthly publication schedule of single numbers will have been established, the numbers containing on the average about 3,000 abstracts each. The arrears in publication have been greatly reduced during the year; some still remain but it is expected that during 1930 these will be practically eliminated.

It was hoped that the indexes of Volume I would be issued before the meetings, but this has not been possible. The indexes provide both a systematic topical and alphabetic subject approach to the literature, and as such will, it is believed, prove unusually serviceable. Their initial organization, however, is a difficult and time-consuming task. The editors are adhering steadily to the policy of setting reasonably high standards and working out sound policies and procedure, knowing that in so doing speed of issuing subsequent indexes will be greatly increased and the quality safeguarded. The systematic index, which has been difficult because it involves adoption by the section editors of systems of classification of the groups throughout the organic kingdom, is practically all in type and partly proof read. The subject index with its innumerable problems is partly in type and will be wholly so within the next two months. The indexes of Volume I may therefore be expected confidently in the Spring.

The seriousness of the delay in the indexes is appreciated. It is hoped however that biologists will approve the policy of proceeding sufficiently deliberately to establish sound policies and standards in the initial effort. It should again be pointed out that the permanent reference value of an abstracting journal depends almost wholly upon the quality and completeness of its indexes.

Aside from progress in publication the most significant development of the year is the cooperation from the Federal Department of Agriculture, which made possible on July 1 last the establishment of a branch office in the Department of Agriculture Library at Washington. All incoming library material is seen by the Biological Abstracts staff and all journals with suitable biological content not already perused at Philadelphia or elsewhere are covered. As there is no institution in Philadelphia primarily concerned with agriculture, this development makes good one of the chief deficiencies in Biological Abstracts by insuring full representation in fields partly or largely served by agricultural and related serials, notably, economic entomology, plant pathology, many phases of bacteriology, animal production, horticulture, agronomy, forestry, and to a lesser degree many other fields represented by sections in Biological Abstracts. The results will shortly be evident in the printed issues. For this cooperation the Federal Department has made available about $5000 for salaries and current operation and about $5000 for serials desired both by Biological Abstracts and the Department of Agriculture Library.

Thus the number of current serials examined first hand has been brought to about 5500—about 2500 at the Academy of Natural Sciences of Philadelphia; 1200 at the College of Physicians (Philadelphia), 1200 at the central office; and 600 at the Department of Agriculture Library. Over 3000 collaborators, representing every country with biological activity, provide the bulk of the abstracts; the journal, like science itself, is thus a cosmopolitan rather than a sectional or provincial product. As soon as conditions warrant it is planned to consult at the Surgeon Generals Library all pertinent serials not already taken care of elsewhere. When this is done fair completeness should be reached, probably bringing the number of serials examined to about 6000.

Attention is again called to some of the fundamental considerations which led to the creation of a comprehensive and inclusive abstracting journal for biology. Research in biology, as in other sciences, is steadily becoming more specialized. This has been accompanied by the establishment of a larger and larger number of more or less correspondingly specialized abstracting journals, highly useful but inevitably tending toward isolation and separation of closely related fields. This tendency is analytic. But with narrower specialization comes the increasing problem of synthesis; we are still concerned with wholes. Also, impetus to progress in a given field comes quite as often from another direction as from advances in the field itself. Hence, Biological Abstracts through its sectional arrangement is attempting to meet the analytical needs of the specialist; but at the same time through its comprehensiveness to make a substantial contribution to synthesis and to enable specialists to take advantage easily of advances in other fields which may have application to problems in their own.

Reassuring in this connection is the fact that the size of the inclusive service, which gave rise earlier to some concern, is well within the prediction of the committee in charge of planning the service. It will be some years before the journal occupies as much as five inches of shelf space annually; Chemical Abstracts has long been bulkier than this, as was Botanical Abstracts in its later years. Typography, format, and paper combine to make the journal extremely economical of shelf space.

The present subscription price is $15 annually, with a 40 per cent reduction ($9 net) for personal subscriptions. With the increasingly strong support of individual biologists through subscriptions it is believed that these rates can be maintained even when the journal has reached approximate completeness. Without this support

the journal cannot reach its goal. The practical question is whether biologists in large numbers are willing to invest nine dollars a year in their cooperative enterprise to provide in the near future a thoroughly adequate, substantial, and enduring instrument, and in this respect place biology on an equal footing with chemistry.

The single strong comprehensive abstracting and indexing journal in chemistry has made available a splendid service, admittedly adequate and indispensable for chemists, at a cost to the American Chemical Society of about $10 per member, each of whom through the annual society dues supports the abstracting journal. In biology with the development of a very large number of highly specialized abstracting journals, many of them costing from $30 to $75 and over annually, equally complete service entails an annual subscription outlay of between $500 and $1000, though the literature covered by them is only about one-third to one-half greater than that covered by Chemical Abstracts.

A definite start has been made in Biological Abstracts; it is believed that there is no insuperable obstacle in the way of developing it into a service which will serve biologists as adequately as Chemical Abstracts serves chemists. There have been many delays, shortcomings, etc., regretted as much by the editors as they may have irritated and disappointed subscribers; but one by one they are being overcome, and we appeal to the steadfast support of all biologists (who by an overwhelming referendum vote approved the initiation of the journal) through subscription and collaboration to bring the journal to full development and establish firmly an agency able to cope permanently with the rapidly increasing complexity of the literature.

A. L. QUAINTANCE

PRESIDENT T. J. HEADLEE: Next is the report of the Committee on Nomenclature.

After J. A. Hyslop read the report there was considerable discussion, particularly as to how many votes for and against a certain common name for an insect should form the basis for the approval or rejection of that common name by the Association. In view of the fact that the Committee might wish to make some changes in its report it was voted to allow the Committee to bring in another report at the final business session, January 1.

PRESIDENT T. J. HEADLEE: The next item of business is the report of the Committee on Endowment.

No report was made.

PRESIDENT T. J. HEADLEE: The next item of business is the report of the Editorial Board on Index to Economic Entomology.

REPORT OF EDITORIAL BOARD ON INDEX TO AMERICAN ECONOMIC ENTOMOLOGY

Acting under the authority given at the last annual meeting, your committee arranged through the courtesy of Dr. C. L. Marlatt, U. S. Bureau of Entomology, for the compilation of the references for Index 4 to cover the five year period ending December 31, 1929. Information at hand indicates that material progress has been made, that the size of the volume will be approximately that of Index 3 and that

the material may be assembled and ready for the printer early in 1930. The same general policy is being followed in regard to the selection of items for inclusion, though less attention has been given to agricultural papers, since a relatively much smaller amount of original matter is published in these serials. Very little anonymous material is included. It is planned to include in the Index the recognized common names of insects.

The action at the last annual meeting authorized the Editorial Board to proceed in its discretion with the publication of the Index and to fix as heretofore the price of copies. The above may therefore be considered as a report on the progress made and unless some material objection develops, the Editorial Board will proceed to complete the project.

Respectfully submitted,
E. P. FELT
C. W. COLLINS
D. M. DELONG

Voted that the report be adopted.

PRESIDENT T. J. HEADLEE: Next is the report of the Board of Trustees for Permanent Fund.

REPORT OF THE BOARD OF TRUSTEES OF THE PERMANENT FUND

Deposited in Melrose Savings Bank November 19, 1928		$5315.04
Interest on Liberty Bonds		63.75
Interest on Bank Deposit		237.20
Received from Secretary:		
Interest on funds of the Association	$280.55	
Transfer from Association Fund	500.00	
Transfer from JOURNAL Fund	200.00	980.55
		$6596.54
4¼% Liberty Bonds		1500.00
GRAND TOTAL		$8096.54

Respectfully submitted,
A. F. BURGESS, *Chairman*
C. W. COLLINS
G. M. BENTLEY
T. J. HEADLEE

There was some discussion as to whether some of the Fund could be invested to better advantage. L. S. McLaine made a motion which, as finally adopted, took the following form: "Moved that it be suggested to the Board of Trustees for Permanent Fund that they consider investing an additional part of the Fund in bonds. It was then voted to adopt the report.

PRESIDENT T. J. HEADLEE: The next item of business is the report of the Committee on National Museums.

REPORT OF THE COMMITTEE ON NATIONAL MUSEUMS

Previous reports have stressed the need of more adequate support for the Division of Taxonomy of the Bureau of Entomology of the United States Department of Agriculture. This Division serves all entomological workers in the United States. It should be in a position to attract and hold leading specialists in all groups of insects. The same statement applies equally well to the situation in Canada.

The service provided by National Museums of Canada and the United States to entomologists of the North American Continent has been invaluable but the demand so far exceeds the facilities for fulfilling the needs that prompt identifications are often impossible. The prompt identification of an insect may permit effective control of a serious pest, or in the case of an introduced species may permit immediate effective operations which would have been ineffective without prompt recognition.

To a large degree the development of economic entomology in the United States and Canada is dependent on the development of the insect divisions in our National Museums so that they can serve the entomologists and indirectly all the citizens of these countries.

Adopting reports of this committee from year to year will accomplish nothing if the individual members of the Association do not do their part. A start has been made this year by advising certain senators and representatives in the Congress of the United States of the importance of the taxonomic work and the need of more adequate support.

We urge that all entomologists in the United States write their representatives and senators promptly and inform them of the great need for more adequate support for the Taxonomic Division of the Bureau of Entomology.

Respectfully submitted,
J. J. Davis
H. H. Knight
E. C. Van Dyke
A. W. Baker
R. W. Harned, *Chairman*

Voted that the report be adopted.

President T. J. Headlee: The next item of business is the report of the Coordinating Committee on Program

No report was given.

President T. J. Headlee: Next is the report of the Committee to Formulate Plans for Investigation of the Codling Moth from Biologic and Control Standpoints.

REPORT OF COMMITTEE TO FORMULATE PLANS FOR INVESTIGATIONS OF THE CODLING MOTH FROM BIOLOGIC AND CONTROL STANDPOINTS

This Committee has continued to function along the lines indicated in previous reports. On January 3, 1929, following the New York meetings, a general conference was held at Washington, attended by some 44 entomologists and others concerned with the problem of codling moth control and spray residue. The results obtained the previous season, and plans for the coming year, were discussed. Minutes of the meeting, including abstracts of reports sent in by workers unable to attend the conference, were circulated among the participants and others interested.

A similar roundup will be held February 10, 1930. A mimeographed summary of the information brought out at this conference will be later furnished to the workers in attendance, and will also be available to others on request.

Respectfully submitted,
A. L. QUAINTANCE
B. A. PORTER
G. A. DEAN
LEROY CHILDS
P. J. PARROTT
W. P. FLINT

Voted that the report be adopted.

PRESIDENT T. J. HEADLEE: The next item of business is the report of Committee on Research Work on the Control of the European Corn Borer.

REPORT OF THE JOINT COMMITTEE ON EUROPEAN CORN BORER

The European corn borer has continued its natural spread since its discovery in America in 1917. Its average rate of advance to the South and West has been from 25 to 30 miles per year. In 1929 it occupied 10,000 to 12,000 square miles of new territory in the United States. It now occurs throughout the southern portion of Quebec and Ontario, as well as locally in New Brunswick and Nova Scotia in Canada, the southern two-thirds of New England, the northern extremity of New Jersey, all of New York, three-fourths of Pennsylvania and Ohio, the Panhandle of West Virginia, nearly all of the agricultural portion of Michigan and the northeastern fourth of Indiana. It has now reached the threshold of the main Corn Belt.

The corn borer is only thinly distributed over the newly infested territory and causes no apparent injury. It increases in numbers rather slowly at first and, judging from past experience, will not cause evident injury in the first two to four years. This provides a period during which the entire community should obtain and apply the latest recommended control measures. In most of the older infested areas, the borer has increased greatly in numbers. Where this insect has been established for several years, commercial damage to corn now occurs unless natural factors have checked the borer temporarily or adequate control measures have been applied. If this is true in the eastern edge of the Corn Belt, where most of the corn is cut and much of it put in the silo, thus simplifying an adequate clean-up, how much more will it be true in the main Corn Belt where most of the stalks are left in the field?

It, therefore, is still the opinion of the Joint Committee that, unless the corn borer is controlled, it will become one of the most destructive crop pests ever introduced into America. The situation, presenting as it does, the possibility of enormous agricultural losses, calls for the continued cooperation of the farmer, the scientist, the educator, and all State and Federal administrative officials.

The cooperating committee of entomologists, agronomists, agricultural engineers, agricultural economists, and animal husbandmen, most heartily endorses all endeavors to control the corn borer, and commends the efforts of all farmers practicing control measures and all persons engaged in the research, regulatory, and educational activities.

The committee recognizes the necessity for the continued development of the research, educational, and quarantine programs of the State and Federal Governments and earnestly recommends the appropriation of the funds necessary to maintain these activities, and expand them when necessary.

After careful and complete investigation of the corn-borer regulatory, research, and educational activities, the committee suggests and recommends:

1. That since the quarantine efforts have been successful in preventing long-distance spread by artificial means, and since the only known spread of any importance in the United States has been by the natural flight of the corn-borer moths or by water drift of infested material, the quarantine activities of the Federal Governments of the United States and Canada should be supported and encouraged by the States and Provincial Agricultural Colleges and Experiment Stations, the State Departments of Agriculture, and all other agencies interested in the welfare of American agriculture.

2. That because the clean-up in certain of the infested areas has not been complete and the borer population is increasing, quarantine action is much more imperative.

3. That scouting should be continued in the areas contiguous to known infested areas and extended to the larger corn-producing States where areas seem particularly exposed to infestation. Ample funds should be available for a thorough clean-up of isolated infestation in such areas.

4. That two primary methods of control of the corn borer are recognized, namely, (a) the utilization or destruction of all host plant remnants each year, and (b) the somewhat later planting of corn. To facilitate the first of these methods labor saving tools and farm machinery should be devised or improved as rapidly as possible.

5. That gratifying progress in European Corn Borer research has been made during the past year. Certain phases have already yielded results from which conclusions of both practical and technical value have been drawn. On the other hand, the committee wishes to emphasize the necessity for continued effort in each of the major lines of entomology, agronomy, agricultural engineering, agricultural economics and animal husbandry. While certain lines of work have served their purpose and should be discontinued along with those that have been found unfruitful, there are still many problems requiring continued study as well as others yet unattacked and it is urged that future emphasis be given these. In addition, the committee suggests that all major phases be expanded so far as practicable, into corn-belt States not yet infested with the borer.

Respectfully submitted,

American Association of Economic Entomologists

G. A. Dean — D. J. Caffrey

L. Caesar — J. J. Davis

C. J. Drake

American Society of Agronomy

L. E. Call — J. F. Cox

W. L. Burlison — R. M. Salter

F. D. Richey

American Society of Agricultural Engineers

C. O. Reed — A. L. Young

S. H. McCrory — R. B. Gray

R. D. Pardon

American Farm Economic Association

C. R. Arnold — H. M. C. Case

O. G. Lloyd — A. G. Black

C. L. Holmes

American Society of Animal Production

E. W. Sheets — Paul Gerlaugh

F. G. King — G. A. Brown

F. B. Morrison

Committees

Voted that the report be adopted.

PRESIDENT T. J. HEADLEE: The next item of business is the report of the Committee on Recommendations to Secretary of Agriculture with Reference to Needs for Foreign Stations to Study Insect Pests, Plant and Animal Diseases Introduced or Likely to be Introduced.

MR. HERBERT OSBORN: I am sorry I cannot make a positive and definite report as to the results of the action of this Committee. The committee is a cooperative one with the Society of Plant Pathology and as chairman I work with Dr. C. R. Orton in connection with that matter.

I was in Washington in April and talked with members of the Department there, the Bureau, with Director Woods, who was very cordial indeed with regard to this proposition and advised me to take it up with Assistant Secretary Dunlap. I talked with him and he was very much enthused and thought it was desirable to have this work done in other countries to determine what insects were likely to come into this country and affect the results of economic entomology here. He arranged an interview with Secretary Hyde who was very, very cordial indeed to the proposition. He proposed to have a committee right there to push the matter and promised that provision for it should go into the budget if recommended. The item was put into the budget and, as I understand, received favorable consideration.

I saw Dr. Orton the other day and he said the item was in the budget under some general title, and he wasn't sure how much would be available for this purpose. The result from Congressional action is something I cannot report on with any certainty at the present time. It apparently had very cordial consideration and I hope we are able to get some results.

Voted that the report be adopted and the committee continued.

PRESIDENT T. J. HEADLEE: Let us now have the report of the Committee on the Training of an Entomologist.

REPORT OF THE COMMITTEE ON THE TRAINING OF AN ENTOMOLOGIST

In accordance with vote of the Association, a committee has been at work on a study of the subject matter entering into the training of an Entomologist. The work is only begun, and in the thought of the present committee it is an undertaking that will and should continue for a long period. The present report therefore, is simply one of progress.

The Committee wishes to make clear to the members of this Association the fact that it conceives of its duties as in no wise the setting up of a hard and fast formula for professional training in entomology. Thoughts as to the make-up of such training

must vary. There are and will be as many ideals as there are men, so far as final details are concerned. It should be possible, however, to bring together these ideals, to see at what points they coincide, and thus eventually, we hope to set forth and emphasize some fundamentals. This is the present committee's conception of its task.

In order to make a beginning, the committee has asked a number of men, who represent various specialized aspects of professional entomology, to submit to the committee the plan that each one, if he had a free hand, would like to see followed in the selection and arrangement of the studies that a man should pursue from his freshman year to his doctorate, in order to fit himself for that particular aspect of the profession. The statements are now before the committee and are being studied, both as to their broad aspects and as to their details. It is the plan to ask for similar statements from other members, both those who are training entomologists and those who are not in teaching work.

It is too early yet to offer to the Association any generalizations from these studies. Manifestly they raise far-reaching questions: for example, the problem of assuring to the student, by some effective means, a broad vision of human life and work and a sympathetic appreciation of the bearings of his profession on other human activities; or, again, the equally difficult problem of providing an adequate equipment of specialized subject matter within the range of total time available.

The suggestions and plans already before the committee constitute an exceedingly interesting body of data. Members have formulated proposed curricula that afford an admirable approach to the task in hand. These suggested curricula have been interpreted in many cases, by extended discussion of the relationships involved in the selection of studies proposed. The committee feels that it has much valuable material in these communications.

The committee wishes to invite members of the Association to communicate their suggestions. It desires that members shall feel free to express their thoughts as to any aspect of training, broad or narrow, to which they are giving attention or on which they hold convictions.

It is hoped that by the time of next year's meetings some tentative proposals may be formulated. In the meantime it is suggested that the committee be continued, for further study of the problems under consideration.

H. J. Quayle
A. C. Baker
W. A. Riley
C. J. Drake
W. C. O'Kane, *Chairman*

Voted that the report be adopted.

President T. J. Headlee: There is a Committee operating by virtue of an appointment by the Executive Committee during the time between sessions of which Professor W. P. Flint is the chairman.

REPORT OF THE SUB-COMMITTEE ON ENTOMOLOGICAL EXHIBITS FOR THE CHICAGO CENTURY OF PROGRESS EXPOSITION

The Committee has approved the plan of exhibits drawn up at the time of its first meeting. They feel that the exhibit could best be arranged in the form of a number of units occupying rectangular spaces. The committee has approved of an exhibit consisting of 16 units which would occupy a floor space of from 10,000 to

12,000 square feet, including the aisle space necessary around the exhibits. It was decided to build these units around the following subjects:

SUBJECT	Planning assigned to
Introduced Pests	Prof. L. S. McLaine
Spraying, Dusting, Fumigating, Insecticides, Appliances and Equipment	Prof. T. H. Parks
The Value of Insects to Man	Dr. E. F. Phillips Dr. F. E. Lutz
Mass, Number and Kinds of Insects as Compared with Other Animals	W. P. Flint
Biological Control of Insects	Prof. G. A. Dean Dr. W. H. Larrimer
How an Insect Lives	Dr. C. L. Metcalf
Insects as Carriers of Plant Diseases	Prof. T. H. Parks, Dr. F. E. Lutz
Insects as Carriers of Diseases of Man and Other Animals	Dr. F. C. Bishopp
Insects that Feed on Field Crops (with the Grasshopper as a typical example)	Dr. W. H. Larrimer
Insects Attacking Cotton (with the cotton boll weevil as a typical example)	Dr. W. E. Hinds
Insects as Pests of Growing Fruits (with the codling moth and some citrus insect as typical examples	Dr. T. J. Headlee
Amount and Kinds of Taxes Collected by Insects	Prof. J. J. Davis
Household Insects (including carpet beetles, termites, bed-bugs, and clothes moths as typical examples)	Dr. C. L. Metcalf W. P. Flint
Stored Grain Insects (showing bran bugs, grain moths and grain beetles as typical examples)	Prof. G. A. Dean
Ants and Aphids	Prof. J. J. Davis
Shade Tree and Forest Insects (with the Gypsy moth and bark beetles as typical examples)	Dr. T. J. Headlee Prof. L. S. McLaine

The actual planning and arrangement of each of the units has been assigned to individual members of the committee, with the request that they call on other entomologists for assistance in drawing up the plans for the individual units. These plans are to be ready at the time of the next meeting of the committee which is to be held at the time of the North Central States Entomologists Meeting in Lafayette, Indiana, the first week in March.

Respectfully submitted,
W. P. FLINT, *Chairman*

Voted that the report be adopted.

PRESIDENT T. J. HEADLEE: We are now ready for the item of business entitled "Appointment of Committees." The chair will tell you of the appointments he has made.

Committee on Resolutions: A. G. Ruggles, E. D. Ball and J. S. Houser.

Committee on Audit: L. B. Smith and T. H. Frison.

Committee on Nominations: L. Haseman, C. H. Hadley and Arthur Gibson.

PRESIDENT T. J. HEADLEE: The next item is miscellaneous business.

PRESIDENT T. J. HEADLEE: The next item is new business.

Vice-President F. N. Wallace assumed the chair.

(At this point the President delivered the annual address which appears in Part II.)

Final Business

The final business was transacted Wednesday afternoon, January 1, after the reading of papers was completed. Before all papers had been read, however, Prof. G. M. Bentley presented a resolution pertaining to the Mediterranean fruit fly. There was considerable discussion concerning the resolution, especially as to the advisability of its containing the word "eradication." The resolution which was finally adopted in its original form, reads as follows:

MEDITERRANEAN FRUIT FLY RESOLUTION

Whereas, The presence of the Mediterranean Fruit Fly in Florida creates a situation fraught with the gravest danger to the horticultural and agricultural industries of the Southern and Western States, and

Whereas, The presence of this pest, one of major importance, constitutes a threat to the prosperity of the areas affected and exposed, and unless eradicated, will also affect very materially the interests of the consuming public of the nation, and

Whereas, By reason of this situation, the problem is one of national rather than sectional import, and

Whereas, The program of eradication adopted by the Federal Government has been prosecuted vigorously and effectively, and

Whereas, Competent and able authorities, after intensive study, are convinced that eradication is not only possible, but is actually being accomplished, now, therefore,

Be it Resolved, By the American Association of Economic Entomologists in session at Des Moines, Iowa, this 1st day of January, 1930, that the program as adopted and announced by the Secretary of Agriculture, Honorable Arthur M. Hyde, should be supported by the public and the scientific workers of this country, and further, that the appropriation of adequate funds by Congress for the prosecution of this project is of paramount importance and should be made speedily available.

An announcement from Prof. D. C. Mote, Chairman of the Pacific Slope Branch, was also read. It was to the effect that a cordial invitation is extended to all members of the Association to attend the meetings of the Pacific Coast Branch at Eugene, Oregon, June 19 and 20, 1930.

The final business session follows:

President T. J. Headlee: We will now open the session for final business. First is the report of the Committee on Resolutions.

REPORT OF COMMITTEE ON RESOLUTIONS

Your committee submits the following resolutions:

1. Resolved, That we as members of the American Association of Economic Entomologists in the forty-second annual meeting assembled hereby record our sorrow in the loss of Professor J. W. McColloch and be it further resolved that the Secretary be instructed to convey our sympathy to Mrs. McColloch and her children.

2. The American Association of Economic Entomologists wishes to express its thanks to the authorities of the Iowa State College and especially to the members

of the Department of Zoology and Entomology for the many courtesies extended and for the efficient arrangements which have contributed much toward the success of this meeting.

3. This Association appreciates the attitude toward scientific research expressed by the members of the Iowa State Legislature in setting aside a special fund to be used in defraying a part of the expenses incident to this meeting.

(Signed)

A. G. RUGGLES
E. D. BALL
J. S. HOUSER

Voted that the report be adopted.

PRESIDENT T. J. HEADLEE: Next is the report of the Committee on Membership.

REPORT OF COMMITTEE ON MEMBERSHIP

Your committee begs to submit for your approval the following report on its activities during the past year and recommends that the following five candidates be reinstated to Associate membership:

George G. Ainslie
D. W. Grimes
E. C. Cotton
Harvey A. Horton
M. C. Tanquary

The committee further recommends that the following 93 Associate members be advanced to active membership:

H. S. Adair
H. B. Armitage
F. E. Baker
Howard Baker
R. A. Blanchard
C. I. Bliss
Floyd F. Bondy
A. M. Boyce
G. H. Bradley
Harry R. Bryson
R. W. Burrell
H. G. Butler
John L. Buys
T. P. Cassidy
K. L. Cockerham
D. M. Daniel
A. C. Davis
E. W. Davis
R. M. DeCoursey
Clifford T. Dodds
P. B. Dowden
W. E. Dunham
J. C. Elmore
G. A. Ficht
G. A. Filinger
A. J. Flebut
R. K. Fletcher
M. H. Ford
O. E. Gahm
Theo R. Gardner
J. B. Gill
J. U. Gilmore
J. M. Ginsburg
G. P. Gray
H. E. Gray
E. R. Grossman
T. T. Haack
R. W. Haegele
G. J. Haeussler
G. F. Henderson
J. G. Hester
J. K. Holloway
F. C. Hottes
H. A. Jaynes
H. E. Johnston
E. P. Keen
E. G. Kelsheimer
J. W. Lipp
V. A. Little
H. J. MacAloney
H. S. McConnell
F. L. McDonough
T. F. McGehee
Miyanoata McPhail
F. W. Metzger
D. F. Miller
A. V. Mitchener
Dudley Moulton
C. R. Neiswander
R. B. Neiswander
A. A. Nichols
M. R. Osburn
R. H. Ozburn
H. J. Pack
R. Painter
W. B. Parker
H. B. Parks
J. O. Pepper
H. S. Peters
J. B. Polivka
C. A. Reese
W. J. Reid
I. L. Ressler
W. A. Ruffin
H. A. Scullen
R. W. Sheppard
F. H. Shirck
R. L. Shotwell
C. E. Smith
S. J. Snow
L. F. Steiner
H. L. Sweetman
J. N. Teubet
J. N. Todd
E. V. Walter
R. A. Wardle
L. P. Wehrle
C. C. Wilson
J. D. Winter
F. H. Wymore
M. S. Yeomans
W. P. Yetter
M. A. Yothers

The committee further recommends that the following 137 candidates be elected to Associate membership:

Thos. C. Allen, Madison, Wisc.
P. N. Annand, Davis, Calif.
Andre Audant, Manhattan, Kansas
A. E. Badertscher, New Brunswick, N. J.
S. F. Bailey, Davis, Calif.
Irene L. Bartlett, Knoxville, Tenn.
T. E. Birkett, Columbia, Mo.
W. E. Blauvelt, Ithaca, N. Y.
Robert Bogue, Hollywood, Calif.
B. F. Boillot, Jefferson City, Mo.
G. L. Bond, Laurel, Miss.
G. T. Bottger, Monroe, Mich.
M. F. Bowen, Logan, Utah
T. E. Bronson, Madison, Wisc.
J. G. Brown, Fresno, Calif.
E. D. Burgess, Melrose, Mass.
E. G. Caldwell, Foley, Ala.
S. L. Calhoun, Marfa, Texas
A. B. Call, Provo, Utah
L. W. Campbell, San Francisco, Calif.
E. W. Cannon, San Jose, Calif.
L. A. Carruth, Brookings, S. D.
R. H. Carter, Washington, D. C.
J. C. Chamberlin, Twin Falls, Idaho
E. R. Childs, San Francisco, Calif.
A. C. Cole, Jr., Columbus, Ohio
Syrus, Conn, Tallulah, La.
R. E. Culbertson, Lexington, Ky.
R. H. Daines, Jr., Logan, Utah
M. M. Darley, Salt Lake City, Utah
F. P. Dean, Yakima, Wash.
F. F. Dicke, Monroe, Mich.
Henry Dietrich, Lucedale, Miss.
Roland E. Dimmick, Corvallis, Oregon
H. E. Dorst, Lawrence, Kansas
W. E. Dove, Dallas, Texas
Verda Dowdle, Logan, Utah
H. W. Dye, Middleport, N. Y.
Walter Ebeling, Beaumont, Calif.
D. F. Farlinger, Cornelia, Ga.
M. D. Farrar, Urbana, Ill.
R. S. Filmer, New Brunswick, N. J.
F. W. Fletcher, Columbus, Ohio
J. C. Frankenfeld, Tempe, Ariz.
J. M. Frazier, Hattiesburg, Miss.
R. A. Fulton, Twin Falls, Idaho
G. I. Gilbertson, Brookings, S. D.
D. G. Gillespie, Hood River, Ore.
J. H. Girardeau, McRae, Ga.
L. J. Goodgame, Aberdeen, Miss.
Kenneth Gray, Corvallis, Oregon
C. H. Griffith, Madison, Wisc.
H. E. Guthrie, Ames, Iowa
C. M. Gwin, Madison, Wis.
F. A. Haasis, Berkeley, Calif.
K. A. Haines, Columbus, Ohio
R. C. Hall, St. Paul, Minn.
D. W. Hamilton, Lyndon, Ill.
A. J. Hanson, Pomona, Calif.
G. W. Haug, A. & M. College, Miss.
Geo. S. Hensell, San Jose, Calif.
W. E. Heming, Guelph, Ont., Canada
J. R. Henderson, Baltimore, Md.
Sam O. Hill, Arlington, Mass.
F. G. Hinman, Pullman, Wash.
G. L. Hockenyos, Urbana, Ill.
Clarence H. Hoffman, Lawrence, Kans.
H. S. Hollingsworth, Wichita, Kans.
Paul Johnson, Brookings, S. D.
P. C. Johnson, Corvallis, Oregon
E. W. Jones, St. Paul, Minn.
G. D. Jones, Jefferson City, Mo.
L. J. Jones, Columbia, Mo.
S. E. Jones, Presidio, Texas
C. P. Jung, Nanking, China
G. M. Kohls, Hamilton, Mont.
J. R. LaFollette, Whittier, Calif.
Horace Lanchester, Parma, Idaho
Setek Ling, Manila, P. I.
B. E. Liston, Lawrence, Kansas
A. H. MacAndrews, Syracuse, N. Y.
Donald McCreary, College Park, Md.
E. R. McGovran, Ames, Iowa
T. E. McNeel, Mound, La.
H. B. Mills, Ames, Iowa
Carl Mohr, Urbana, Ill.
A. W. Morrill, Jr., Fresno, Calif.
L. E. Myers, A. & M. College, Miss.
G. A. Mail, Bozeman, Mont.
G. A. Maloney, Tallulah, La.
G. E. Marshall, Orlando, Fla.
H. C. Mason, Columbus, Ohio
C. C. B. Mayer, Columbus, Ohio
L. W. Noble, Tallulah, La.
Robert A. Perry, Los Angeles, Calif.
Norman H. Plass, Knoxville, Tenn.
A. M. Phillips, Orlando, Fla.
G. L. Phillips, Baldwin, Miss.
J. M. Rasek, Brno, Czechoslovakia
Earl Rannells, Glenn Dale, Md.
L. B. Reed, Picayune, Miss.
(Miss) Hazel W. Riddle, Fargo, N. D.
J. H. Roberts, Baton Rouge, La.
N. A. Sankowsky, Elizabeth, N. J.
F. B. Sazama, Madison, Wisc.
Mlle. Cor. Schaeffer, Paris, France
J. C. Schread, Bridgeport, Conn.
W. A. Shands, Grand Junction, Colo.
H. H. Shepard, Washington, D. C.
Torbert Slack, Lake Charles, La.
G. B. Sleesman, North Glenside, Pa.
J. P. Sleesman, Wooster, Ohio
C. M. Smith, Washington, D. C.
H. A. Stabe, Baton Rouge, La.
W. W. Stanley, Knoxville, Tenn.
J. B. Steinweden, San Francisco, Calif.

La Grande Stirland, Providence, Utah
C. L. Stracener, Baton Rouge, La.
G. R. Struble, Berkeley, Calif.
S. A. Summerland, Bentonville, Ark.
M. C. Swingle, Moorestown, N. J.
R. L. Taylor, Bar Harbor, Maine
H. L. Thomason, Los Angeles, Calif.
L. H. Townshend, Urbana, Ill.
J. E. Tuckett, Indio, Calif.
T. S. Van Aller, Mobile, Ala.
P. A. van der Meulen, New Brunswick, N. J.
L. R. Watson, Alfred, N. Y.
R. J. Webb, Monroe, Mich.
R. W. Wells, Galesburg, Ill.
D. A. Wilbur, Manhattan, Kansas
G. R. Wilson, Alameda, Calif.
D. O. Wolfenbarger, Brookings, S. D.
C. E. Woodworth, Madison, Wis.
J. M. Yeates, Tallulah, La.
G. T. York, Corvallis, Oregon
L. W. Zeigler, Gainesville, Florida

The committee further recommends that the resignations of the following members be accepted:

Active	Associate
Johnson, S. A.	Eaton, E. D. Nakayama, Shonosuke Partridge, N. L.

D. M. DeLong, *Chairman*
H. F. Dietz
S. W. Bilsing

Voted that the report be adopted.

President T. J. Headlee: The next item of business is reports of other committees. Under this head, I wish to call for the report of the Committee on Nomenclature.

Mr. J. A. Hyslop: Before submitting the report I wish to bring up a matter that was referred to the Committee on Nomenclature by the Executive Committee of the Association. This is a communication from Dr. C. W. Stiles relative to proposed amendments to the International Rules of Zoological Nomenclature and is one which our Committee does not believe comes within its province as it deals entirely with technical nomenclature. Therefore, we are referring this back to the Secretary.

REPORT OF THE COMMITTEE ON NOMENCLATURE

Your Committee begs to report that in conformity with instructions received at the last regular meeting of the Association a list of names for 13 insects was submitted to the Association for approval. Of these names only three were approved, and the details of the vote was published in the October number of the Journal of Economic Entomology, Vol. 22, page 825.

Your Committee is convinced of the importance of immediately adopting common names for many of these insects, and is therefore, submitting some of them for your reconsideration. The Committee urgently recommends that each member before passing judgment on these names read the discussion in the October number of the Journal and take into consideration the action of the Association on these names when last they were before the body.

We would particularly call attention at this time to the following:

Laspeyresia molesta Busck must have a common name. The Committee submitted four names for this insect, oriental fruit moth, oriental peach moth, oriental fruit

worm, and oriental peach worm. Oriental fruit moth seems to be the most favored name, although that name received 48 votes opposing it.

Tetranychus telarius L. another important insect, should have an accepted common name. Of the four names submitted, red spider mite seemed to be the most popular. It however, received 77 votes in opposition.

The entomologists of the Pacific Coast have been quite consistent in opposing names for two insects of major importance in that region. They opposed walnut fly for *Rhagoletis juglandis* Cress. and suggested in its stead walnut husk fly, and opposed Pacific flat-headed borer for *Chrysobothris mali* Horn and suggested western flat-headed borer.

Bertha armyworm for *Barathra configurata* Walk. was opposed by eight members. This name, however, has been adopted by the entomologists of the Plains region, and we recommend that the Association adopt it.

The name for *Phytonomus nigrirostris* Fab. has been the subject of considerable controversy, and although a preponderous vote was cast in favor of lesser clover leaf weevil, a third name was suggested which might be a compromise acceptable to each faction.

Ellopia fiscellaria Guen. has been quite generally recognized as the hemlock spanworm in the United States and hemlock looper in Canada, and inasmuch as these names are regional, we recommend the adoption of both.

This Committee is submitting for your approval a list of additional names and wishes to recommend a departure from the usual procedure in that it be authorized to submit these names to the active members of the Association following these meetings for approval or disapproval. If 20 per cent or more of the votes cast for any given name be in opposition to that name the name will be rejected. All other names will be considered accepted.

The Committee further recommends that the approved names be published in Vol. 23 of the JOURNAL OF ECONOMIC ENTOMOLOGY.

J. A. HYSLOP, *Chairman*
E. O. ESSIG
F. C. BISHOPP
H. B. HUNGERFORD
H. G. CRAWFORD

Voted that the report be adopted.

PRESIDENT T. J. HEADLEE: There remains but two regular committee reports, but for fear some committee appointed at some time may have been overlooked and would like to make its report at this time, I will ask this Association if there is any such committee waiting for its chance to make a report. Apparently not. Next is the report of the Advisory Board, JOURNAL OF ECONOMIC ENTOMOLOGY.

REPORT OF ADVISORY BOARD, JOURNAL OF ECONOMIC ENTOMOLOGY

Nominations for Officers for 1930:

Editor, E. P. Felt　　Associate Editor, D. M. DeLong

Business Manager, C. W. Collins

C. L. METCALF
J. M. SWAINE

Voted that the report be adopted.

PRESIDENT T. J. HEADLEE: The Committee on Nominations will now report.

REPORT OF COMMITTEE ON NOMINATIONS

President: Franklin Sherman.
First Vice-President: J. S. Houser.
Vice-President: (Pacific Slope Branch) Don C. Mote.
(Cotton States Branch)
(Eastern States Branch) C. H. Hadley.
(Section of Plant Quarantine and Inspection) E. N. Cory.
(Section of Apiculture) R. L. Parker.
(Section of Extension) C. R. Crosby.
Secretary: A. F. Burgess.

Standing Committees

Executive Committee:
Franklin Sherman, ex-officio — T. J. Headlee, term expires 1932
A. F. Burgess, ex-officio — L. S. McLaine, term expires 1932
Membership Committee: L. B. Smith, term expires 1932
Advisory Board, Journal of Economic Entomology:
Harry B. Weiss, term expires 1932 — J. M. Swaine, term expires 1932
Committtee on National Museums: R. W. Harned, term expires 1932.
Committee on Research Work in Control of the European Corn Borer:
T. J. Headlee, term expires 1934.
Committee on Research Work to Control the Codling Moth:
P. J. Parrott, term expires 1932 — W. A. Ross, term expires 1932
Board of Trustees for Permanent Fund:
Franklin Sherman, ex-officio — C. W. Collins, term expires 1932
A. F. Burgess, ex-officio — E. N. Cory (to fill unexpired term of A. F. Burgess) term expires 1931
(Your committee further recommends that A. F. Burgess continue as chairman).
Representative to National Research Council:
W. A. Riley, term expires 1932.
Councillors for the American Association for the Advancement of Science:
W. E. Hinds — M. H. Swenk
Trustees for the Crop Protection Institute: W. C. O'Kane, term expires 1932.

The Committee respectfully recommends that the present personnel of the following committees be continued: Nomenclature, Endowment, Representatives on the Council of the Union of American Biological Societies, Representatives on the Board of Trustees of the Tropical Plant Research Foundation, and Committee to Co-operate with the Phytopathologists.

Leonard Haseman
C. H. Hadley
Arthur Gibson

Voted that the report be adopted.

President T. J. Headlee: Is Mr. Franklin Sherman here?

Is Mr. J. S. Houser, Vice-President elect, here?

President T. J. Headlee: Will Dr. Hinds and Dr. Haseman escort the Vice-President elect to the platform?

Dr. Houser was escorted to the platform.

PRESIDENT T. J. HEADLEE: It gives me the greatest possible pleasure to turn over this symbol of authority over this great Association into hands so capable as yours. I am sure you will enjoy handling it in keeping this crowd reasonably straight. Don't keep them too straight.

VICE-PRESIDENT J. S. HOUSER: In behalf of President Sherman, I accept this gavel in my keeping until I can turn it over to him. I know it is with keen regret that he is not here to accept this honor in person.

The next item of business is that of miscellaneous business. Is there any miscellaneous business to come before this meeting?

VICE-PRESIDENT J. S. HOUSER: Next is the fixing of time and place of the next meeting.

MR. J. A. HYSLOP: I move that the next meeting of the Association of Economic Entomologists be held at the time and place of the meeting of the American Association for the Advancement of Science.

The motion was carried.

VICE-PRESIDENT J. S. HOUSER: The next item of business is the final adjournment.

At this point Mr. J. A. Hyslop again made reference to the communication from Dr. C. W. Stiles relative to proposed amendments to the International Rules of Zoological Nomenclature. After some discussion Mr. Hyslop made a motion that the communication be left in the hands of the Executive Committee to be disposed of in such manner as they might deem appropriate. This motion was carried.

FINAL ADJOURNMENT: 3:50 P. M.

PART II. ADDRESSES, PAPERS AND DISCUSSIONS

The session for presentation of technical papers convened immediately following the business session of Tuesday morning, December 31, with Vice-President F. N. Wallace in the Chair.

VICE-PRESIDENT F. N. WALLACE: Next is the annual address of the President, T. J. Headlee.

SOME TENDENCIES IN MODERN ECONOMIC ENTOMOLOGICAL RESEARCH

By THOMAS J. HEADLEE, Ph.D., *President*
American Association of Economic Entomologists

ABSTRACT

To meet his problems the economic entomologist must be looking ever more deeply into the nature of insect life and its reaction to the physical and biological environment in which it is found. His sweep of basic information must involve a

working knowledge of the principles of physics, chemistry, biology and entomology. He must not neglect any phase of entomology as being unimportant for his purposes. His organization for research must involve the physical, chemical, biological points of view as well as the taxonomic, structural, developmental and physiological standpoints of his specialty. The fields of chemical control is now coming into its own. The field of biological control is just opening up as is also the field of physical control. The opportunities for accomplishment in public service through economic entomological endeavor never were greater but the difficulty of the problems involved is constantly increasing and demanding greater and greater keenness.

Introduction

In dealing with any subject to which the human race has given attention, it is axiomatic that racial experience forms a pretty safe guide. Consideration of the subject of economic entomological research should, therefore, logically be preceded by a brief account of racial experience, at least in so far as it relates to biological research.

The first step in arriving at an understanding of the world of living organisms has been an attempt, on the basis primarily of structure but secondarily of function, to assemble individuals of similar structure and physiology into groups and to assemble the groups of like character into larger classes and finally thus synthesize the whole world of living organisms. The net result of this effort has been the development of the conception of the plant and animal kingdoms composed of great primary groups, each group being in its turn composed of many fundamental sub-classes, each sub-class in its turn being divided into its sub-groups or families, each family into its component genera and each genus into its component species. For many years students were concerned very largely, if not almost solely, with taxonomy.

The second step in arriving at an understanding of the world of living organisms was taken when students turned their attention to the gross and minute structure of the species characteristic of these great taxonomic groups. This study in turn reacted upon the constitution of the taxonomic group, for characters were found in many instances which afforded better means of separating one group from another.

The third step was taken when students turned their attention to the embryonic and post-embryonic development of individuals composing these great taxonomic groups. Information obtained from this phase of the investigation threw a flood of light upon taxonomic relationships and greatly modified the taxonomist's conception. Indeed this light was promptly utilized by a large group of students who pushed its conclusions into the taxonomic field to modify the previous conception of taxonomic structure of living organisms.

The fourth step was taken when students turned their attention to the study of the functioning of the characteristic organisms composing these great taxonomic groups. Various names were applied to this fourth movement, such as experimental zoology, ecology, etc. The fact is that the movement designated as the fourth step is truly the beginning of the development of what we today know as physiology.

The science of entomology, which may be defined as the body of facts relative to taxonomic relationships, morphology and development, and physiology of insect life, has experienced a similar development. First came the insect taxonomist, then came the insect anatomist and histologist, who was followed by the student of embryonic and post-embryonic development and finally in our present day we see the beginning of the work of the insect physiologist.

The science of economic entomology, which may be defined as the body of facts relative to the relationship of insect life and activity to human life and activity, has centered its attention upon the ways in which insect life affects man's welfare and upon an attempt to find out ways and means for controlling insect activity, of either a beneficial or injurious nature, insofar as it relates to the success of human endeavor. Obviously, in following out this line of study, insect activity became the primary consideration and so we find early economic entomologists devoting their attention almost entirely to the study of life history and habits of insects known to be injurious or beneficial to human welfare. The economic entomologist, was, therefore, the earliest student of insect function and he assumed that position by reason of the nature of the effort in which he was engaged. His studies first covered the more obvious and simple phases of insect activity but with the passing years he has been looking ever more deeply into insect activity and into methods that can be used for its control.

This change in point of view of the economic entomologist is rather well illustrated in some of the addresses of the ex-presidents of this association. We find H. A. Morgan in 1907 saying that timely correlation of thoroughly matured knowledge of agricultural conditions with an exhaustive study of life history and habits of economic insects offers the best opportunity for proper control of their activities. We find S. A. Forbes in 1908 looking toward the study of environmental relationship as the next step most likely to yield great results in protecting the public from insect injury. Again in 1914 we find H. T. Fernald advocating more exhaustive studies on life history and habits, insecticides, and ecology of both domestic and foreign species of insects. In 1917 we find C. Gordon Hewitt stating that insect behavior con-

stitutes the basis for applied entomology. In 1928 we find W.B. Herms advocating the experimental method as the most important tool for research in economic entomology. It is very interesting to note that all of the workers mentioned realized the necessity of looking ever more deeply into insect activity as the only proper and satisfactory basis for discovering adequate measures of controlling it.

Analysis of the Nature of an Economic Insect Problem

An economic insect problem always involves one or more definite species of insects and one or more definite species of hosts. Taxonomic considerations at once become of prime importance in order that the key to accumulated human experience relative to the activity of the species concerned may be secured. The economic entomologist would do well to ponder the importance of this key because it can be used to unlock stores of information which may have a large bearing upon the problem with which he is faced.

An economic insect problem involving, as it always does, one or more species of insects and one or more species of hosts demands as a basis for its solution a knowledge of anatomy, histology, embryology, and post-embryonic development of the insect or insects concerned. Failure to possess this information is apt to be followed by overlooking the best method of effecting control.

An economic insect problem involving, as it always does, one or more species of insects and one or more species of hosts requires a fundamental understanding of the reaction of the insect or insects to environmental factors, and to the host or hosts in their various stages of development present in this environment. Furthermore, the solution of this problem may require a fundamental understanding of the reaction of the host or hosts to the fundamental factors of the environment including the insect or insects concerned.

The economic entomologist must, for the solution of an economic insect problem, know: (1) The taxonomic status of the economic insect or insects in order that he may unlock accumulated human experience in dealing with the species concerned; (2) the morphology and development of the species concerned in order to grasp that fundamental basis for control procedure; and (3) the internal and external physiology of the economic insects concerned as a basis for deriving clues to control.

The economic entomologist is at the present time in the greatest danger of overlooking the value of the taxonomic status of the economic insect or insects and in the next greatest danger of overlooking the value of the morphology and embryonic development of the economic insect or

insects because his attention is centered upon insect activity. He stands in the further danger of limiting studies of insect activity to life history and habits and depending upon them solely for his clues to control. Of course, the studies of insecticides, particularly of a chemical nature, have now been given enough attention that he is very likely to add them to a consideration of the problem of control. The study of the reaction of the economic insect or insects concerned to fundamental environmental factors covering temperature, moisture, sunlight, wind movement, barometric pressure, nature of the host's epidermis and cell sap, volatile gases constantly being evolved from the host, and the natural predacious and parasitic enemies, is merely in its infancy and is today the promised land of future years for the economic entomologist. To take advantage of this most attractive and promising field of endeavor the economic entomologist must be able to think not only in terms of general biology but also in terms of chemistry and physics.

Methods of Attacking an Economic Insect Problem

Ex-president W. B. Herms said that the experimental method is the most important tool of research that entomologists use. Now what is the experimental method? It is the method which the investigator uses to secure a reliable answer from the organism in response to applied stimuli, the value of which he wishes to learn. The practice of this method involves fundamentally the utilization of scientific proof. The understanding of scientific proof is a matter of sufficient importance to justify a moment's consideration. Theoretically in the process of scientific proof all variables, save the one concerning the effect of which information is desired, are reduced to zero. The insect is placed under controlled conditions, the effect of which is understood, and the environment of the experimental group is made identical with the environment of the check group, with the exception of the one variable concerning which the investigator desires information. Thus the insect may be made to answer the question of how and to what extent this variable affects it.

Now, it is readily realized that the securing of this ideal set of conditions may be, and frequently is, extremely difficult. Many methods have been utilized to approximate this condition, and among them the use of large numbers of individuals, many duplicate experiments, and the covering of a considerable number of seasons and of wide geographic territory stand out prominently as rendering worthwhile service. It is frequently said that the best way to secure results of studies of codling

moth in one part of the country that will be comparable with studies of codling moth in another part of the country is to perform the experiments in exactly the same way in each of the different places. This assumption of comparability of data secured under this plan is thought by the writer to be fallacious because no two workers can perform a given set of experiments in the same way. The human factor variable is too large. It is the writer's belief that more comparable results will follow the practice of each worker conforming his study to the requirements of sound scientific proof and carefully stating the conditions under which the work was done.

When the economic entomologist is confronted with the need for a solution of an economic insect problem he must, if he is going to get the best results; review the literature pertaining to the insect or insects involved covering taxonomic relationship, morphology and development, physiology and control. Perhaps this thorough review and digestion of extant knowledge may reveal one or more clues to control. If so, well and good. It is probably wisest and most economical to begin the pursuit of these clues, following one lead after another until the solution is secured. On the other hand, such a study of extant knowledge may not reveal any clues. In that case it will reveal the gaps in information. With these gaps in mind the investigator must, unless his organization is so large as to attack them all, use keen judgment in selecting the one, the filling of which is most likely to furnish him with the necessary clues to the solution of the problem. Of course, it is possible for the research man to attempt the exploration of all possibilities and thus employ what in the writer's mind amounts to the shot-gun method but that method involves an enormous expenditure of time and energy.

In using the procedure above discussed the economic entomologist must exhibit the utmost keenness in order to discover clues to control for they are generally somewhat obscure and not easy to pick up.

Organization to Do the Work

If but one man can be employed upon the solution of an economic insect problem that man is necessarily an economic entomologist; for it is to be presumed that, having specialized in that line of endeavor, his mind will be more keenly awake and more sharply on the watch for clues to control and more keenly initiative in following those clues to their logical conclusion. Perhaps if two men are to be employed both should be economic entomologists and possibly the same may hold in the case where three men are employed.

It is the writer's belief, however, that a special type of organization, not hitherto, completely exemplified in economic entomology anywhere in this country is more likely to secure the solution of an economic insect problem in less time and at less cost than any other type of organization with which he is acquainted. This group is, first of all, headed by an economic entomologist, whose background of training and experience is large and covers a broad field. He must have a sense of fair and equitable dealing and he must have a flow of sound ideas that will enable him to enthuse his associates. With him comes a variable number of economic entomologists, one systemic entomologist, one insect physiologist, one biochemist, and one biophysicist. This group must be closely integrated and knit together, working as a unit harmoniously for the solution of the economic insect problem with which it is concerned. It is possible that this group would need at times the services of an economist but that need would arise only occasionally.

Such a group can attack the solution of an economic insect problem from all fundamental points of view. The clues will be more quickly seen, more quickly followed out and the results will be secured in only a fraction of the time usually required to solve an economic insect problem.

Lines of Attack Most Likely to Yield Results

A very large measure of success in insect control attended the efforts of the great economic entomologists of early days, most of whom depended upon a combination of a knowledge of agricultural practices with careful studies of life history and habits of economic insects. In many instances these students of economic entomology made astonishingly successful recommendations based upon these two sources of data. Later many, among whom we should specify Professor S. A. Forbes as an outstanding figure, adopted the practice of testing out in the field under practical conditions the measures of control which their studies indicated as likely to prove serviceable.

Tremendously improved results have followed extensive and intensive studies and utilization of chemical methods of economic insect control. This latter method, the writer would say, is now about in the heyday of its development but there is yet much more to be gained from its pursuit. It is not improbable that, among many other results, thoroughgoing chemical studies will reveal the reason why insects prefer certain host plants, will, under hard conditions, use others, and will perish if compelled to rely for food supply on still others.

The field of the biological control of economic insects, which has received more or less attention from a limited number of workers in

past years, is now beginning to attract earnest, widespread effort. The possibilities of this field for public service are enormous and it, therefore, merits a period of extensive and intensive development. Unfortunately, too many failures have attended efforts to utilize natural enemies as practical means of controlling economic insects. Before best results can be secured in this line of attack, however, sharp attention must be given to the relation of the predator and parasite to the host and to this relationship as affected by the fundamental factors of the physical and biological environment.

To a limited extent physical principles have been utilized in past years for the control of economic insects and certain striking results in the use of dust barriers and temperatures have been obtained. Recently, there has appeared a tendency to examine the gamut of electro-magnetic waves which range, in increasing length, from radium through x-ray, ultra-violet, visible light, infra-red and radio, for possible agents in effecting control of economic insects. Radium, x-ray, and ultra-violet have been shown to have some possibilities. Still more recently electro-magnetic waves, characteristic of the radio bands, have shown ability to destroy insects, ranging through the principal orders, by the process of building up internal heat to a lethal degree. Further, and as yet unpublished, investigations have indicated that there exists a differential in the effect of radio waves upon plant and animal tissue. Should such a principle become established the field for the use of electro-magnetic waves characteristic of the radio bands would be most promising.

The writer cannot forbear mentioning the field of insect quarantine as a proper subject for research. Many students of entomology have had many years of contact with this field and some have become deeply impressed with the dangers to successful economic entomological service attending its present tendencies. There exists in the minds of some, no doubt, whatever, that insect quarantines have been placed and operated which have done far more harm to the interests of the commonwealth than any benefit which can be soundly claimed for them. Economic entomologists would do well to investigate thoroughly the comparative injury and benefit of every quarantine that has been or is now in operation. He will also do well to investigate the comparative benefit and injury of every proposed quarantine before it is placed and becomes operative. Failure to evaluate insect quarantines from the standpoint of injury and benefit to the public is bound to be followed by the placing of some quarantines that do far more harm than good and the reaction of the public to such quarantine activity is apt to be a vigorous discounting of not only all insect quarantines but of entomological service in general.

VICE-PRESIDENT F. N. WALLACE: This paper is now open for discussion. I am sure we will have a wonderful discussion of it.

MR. HERBERT OSBORN: I should like to express my appreciation of the comprehensive address of the President and compliment him upon his covering the ground in such a complete, thorough shape. I am sure the people here will appreciate it and will be interested in it, and I feel very, very confident that the membership of the Society throughout the country will read it with a great deal of profit and pleasure.

MR. W. B. HERMS: I wish, too, to compliment the President on this address which he has given us.

I cannot refrain from referring to one or two of the matters which he has pointed out inasmuch as he referred to the address which I gave a year ago. I am particularly interested in his comments concerning organization for research. Anyone who is responsible for work in economic entomology must look toward a proper organization of his department. It is quite true that we must have our immediate staff of economic entomologists. We must have our taxonomists. We cannot get along without a first-class taxonomist on our staff. We must now have chemists, biological chemists if you please, to help us in the more fundamental problems of insect toxicology; such questions as the permeability of membranes by certain chemicals which we use or may use for the control of a given insect pest—experimental methods. It is very important in that connection.

We must have our physiologist to help us in this very important field of insect nutrition, insect metabolism. We must have a physicist who will help us in the construction and the arrangement of our apparatus which we find so necessary in the study of insect reactions, or light experiments, for example, in our own work in California.

I find it very necessary in my work to have a bacteriologist. We find that the study of the microphagous habits of insects lead us into the realm of bacteriology, and the economic entomologist is rather at a loss to know what to do without an individual who is well prepared in the technique of bacteriology.

That which has been suggested concerning cooperation with other departments is enormously important. We must have the contribution of the plant pathologist, the plant physiologist, and the ecologist.

So I wish to again commend the President on having called our attention to this matter of organization for research.

MR. J. M. RASEK: Please allow me to make a statement here pertaining to this discussion and tell you something of what I believe may interest you, what we in our state are doing in this economic entomological work.

I am a state entomologist in Czechoslovakia, and in the work of our Institute we pay very great attention to two different features in the control of insects. The first is diseases of insects, not only fungous diseases, but especially those caused by filtrable viruses; and in my practice I found that paying attention to the presence of such infection is of great economic value. I will tell you of a case in my practical experience.

It was in the years 1918–1926 that we had in our state a very great increase in population of the nun moth, *Liparis monacha*, feeding on the spruce trees in the forests. According to our forest-protection law, we were compelled to take measures for the control of this insect. Of course, it means very great expense. Normally these expenses are calculated at from 300–500 Czechoslovakian crowns for an area of one hectare.

I sometimes found, in the caterpillars, a disease called wilt disease, or polyhedral disease, which is able to kill those insects. When I found such an infection, I gave notice to the owner of those forests that nothing need be done against this insect because I had found this infection and they could expect the insect would be killed in a normal way and there would be no further increase in population. I believe you can imagine how important that statement was. Of course I had to make many microscopic examinations and study the conditions in those forests; further it was a question whether to take the responsibility for such a statement. I can tell you that in this line I was successful. In case of a large holding (1000 hectares) I was able to save this single owner about 300,000 crowns. The infection was found at the beginning of June one year and there were no caterpillars present the next year, all being killed by this polyhedral disease.

This is one feature that we are emphasizing in the state-entomological work of our country. The second thing is that we pay special attention to the economic value of useful birds and we found many very interesting results. We made a study of hundreds and thousands of stomachs and crops of birds to find out what they were eating. I am sorry I haven't the results of such work here because I left all my slides and photographs at Minnesota, but I can tell you it is highly interesting. We sometimes found as many as 200 or 300 specimens of injurious insects in one stomach. If you extend this compilation over a week or

a month, there are hundreds of thousands of insects destroyed chiefly by the useful birds.

On the basis of those studies, we have now introduced a special system for protecting the birds in an economic way so that they may live under modern conditions in the forest, fields and in the parks. We are now trying to introduce this system on each farm. Especially do we wish to put under control of birds those places which are known to be spreading points of insects. You entomologists know very well that an insect calamity does not start in a great area but usually originates at small, limited spreading points. We are now trying to introduce a very intensive program for the protection of birds at these spreading points in order that they may help us prevent the possibility of an outbreak and the spreading of those injurious insects.

I believe it would be a good idea if you, in your excellent entomological work, would pay attention to those two features of economic entomology.

Adjournment: 12:10 P.M.

Tuesday Afternoon Session, December 31

The session convened at 1:40 P.M., President T. J. Headlee presiding.

PRESIDENT T. J. HEADLEE: The afternoon session of the Association is now open for business.

The first item is a paper by L. S. McLaine.

THE GYPSY MOTH OUTBREAK IN SOUTHERN QUEBEC

By LEONARD S. MCLAINE, *Ottawa, Canada*

ABSTRACT

Canada has been vitally interested in the gypsy moth (*Porthetria dispar*) situation for years. Scouting was carried on in New Brunswick and Nova Scotia in 1921, and was started in Quebec in 1922. Subsequent to the discovery of an infestation within one-half mile of Canadian territory in 1923, more extensive and intensive scouting was carried on in the latter province, which resulted in a single infertile egg cluster being found at Beebe, and quite a severe infestation at Henrysburg in 1924. A total of 2,908 egg clusters were found at Henrysburg, the last in 1926. Control operations consisting of spraying, cresosoting egg clusters, banding and burlapping trees, and burning stone walls were followed. In addition, 6,248 miles of road, 250 miles of railroad, 1,638 miles of main highways leading to large centres, and 11 square miles of woodland, were thoroughly examined. The quarantines placed on southern Quebec by the United States and Canada Departments of Agriculture in 1924, have been rescinded.

The Department of Agriculture for Canada has, for a great many years, been viewing with grave concern the gradual migration of the

gypsy moth both north and northeastward toward the Canadian border. The two areas which were regarded as the ones that might be invaded, were southwestern New Brunswick adjoining the State of Maine, and southeastern Quebec adjoining the States of New York, Vermont and New Hampshire. On more than one occasion, scouting was carried on to determine whether the insect had invaded Canadian territory. In 1921, portions of New Brunswick and Nova Scotia were examined, as reports had been received·that this insect had been seen in certain sections of these provinces, no sign of the insect was found, however. In 1922, owing to the northward spread of the insect in New Hampshire, scouting was carried on in the "eastern townships" of Quebec, which resulted in no discovery of the pest. A report had been received earlier in the year, to the effect that a nursery in the middle west was infested. All importations from this firm were traced and six Canadian nurseries thoroughly inspected. In addition, fifty shipments reforwarded from one nursery were examined at ultimate destination. The result of these investigations were in the negative, and later further word was received that the previous information was incorrect. In the fall of this same year, an International Conference to consider the future of the gypsy moth work was held at Albany, New York,[1] at which it was decided to establish a "barrier zone" extending from the Canadian boundary to Long Island Sound. Canada also undertook to carry on scouting immediately north of the "zone."

In 1923, scouting was continued in southeastern Quebec, in the late fall of this same year one of the largest single gypsy moth infestations ever found in New England was discovered at Alburgh, Vermont, within one-half mile of the Canadian border.[2] Scouting was immediately renewed in Canadian territory north of this outbreak, and by special arrangement, trained scouts were secured from the U. S. Bureau of Entomology for this work, to assist the Canadian field force, but no trace of the insect having crossed the boundary could be found.

The proximity of an infestation such as that found at Alburgh, so close to Canadian territory, made it necessary to consider more intensive and extensive scouting throughout the entire area, with the result, that in the spring of 1924 a field force of thirty-six men was placed in the district. This work was carried on cooperatively by the federal Department of Agriculture and the Quebec Department of Lands

[1]The Gypsy Moth, Agri. Bull. No. 148, Dept. Farms and Markets, Albany, New York, Dec. 1922.

[2]L. S. McLaine—"The Outbreak of the Gypsy Moth in Quebec." Ann. Rpt., Entomological Society of Ontario, 1924.

and Forests. The area in Quebec, it was decided to examine, extended from Huntingdon county on the west, to Compton county on the east, a distance of approximately one hundred and thirty miles, and north from the international boundary about thirty miles.

The first record of the gypsy moth in Canada was the discovery, on July 29 (1924), of a single egg cluster on a willow tree in a piece of swampland in the Beebe river valley, about three miles from the village of Beebe, Stanstead county. An examination of the eggs showed them to be infertile. Intensive scouting carried on in this district, the same season and in succeeding years, failed to reveal any further signs of infestation.

Five weeks later (September 3, 1924), a severe isolated infestation was found at Henrysburg, St. Johns county, approximately three miles due north of the international boundary, and about eight miles northwest of the Alburgh outbreak. The infestation was centered on an old willow adjacent to the road and a few yards from a farm house. The site of the outbreak was on top of a hill which afforded ample opportunity for wind spread and, furthermore, it was one of the few places in the entire district where field stone walls were at all abundant. Of the 2,695 egg clusters treated that fall, 1,043 were found on the willow tree and 1,203 in the stone walls. The "clean up" work was continued in the spring of 1925, which resulted in finding 150 more egg clusters. The work consisted of removing old apple trees, pruning and filling cavities in those that could be saved, banding and burlapping all trees in the vicinity of the outbreak, cutting and burning brush on fence rows, and the re-examination of all buildings. To avoid the great expense of tearing down and rebuilding stone walls in the search for egg clusters, these were burnt over twice with a flame thrower at the time the eggs were due to hatch. Through the cooperation of the U. S. Bureau of Entomology, a power sprayer was loaned for the spraying of the entire area.

Upon the completion of the scouting, the infestation was found to cover approximately one-third of a square mile, seven farms being involved. The infestation occurred on a farmer's milk route and it was the practice for the farmers to take turns in collecting the milk and transporting it to the creamery, as egg clusters were found on the milk stand beside the road, the premises of every farmer on the route were thoroughly inspected. An egg cluster was found on the local school house, and as a precaution the home premises of every child attending the school were examined.

During the re-examination of the infestation in the fall of 1925, one year after the discovery of the outbreak, four new and thirty-six

old egg masses were found. No new egg clusters have been found since that date, although twenty-three old ones were found the following spring, under a low verandah close to the ground. The total number of egg masses found at Henrysburg was 2,908. The Department had only one object in view in handling the outbreak and that was complete eradication, in consequence the entire area was resprayed both in 1926 and 1927, and in addition, all trees were banded and burlapped.

An idea of the amount of labor and material involved in handling a small outbreak may be gained from the fact that 5,500 lbs. of arsenate of lead were used to apply 87,640 gallons of spray; 5,217 trees were banded with 850 lbs. of raupenleim and 4,235 yards of burlap; and over 1,000 yards of wall were burnt.

Apart from the work carried on at Henrysburg, since 1924, 6,248 miles of road and 250 miles of railway have been thoroughly scouted. All the main highways leading from the international boundary to such centres as Montreal and Quebec have been scouted more than once, involving 1,638 miles, and every tree in eleven square miles of woodland surrounding Henrysburg has been examined.

On July 1, 1924, a quarantine was placed on certain sections of Quebec by the United States Department of Agriculture prohibiting the importation of Christmas trees. On September 3, of the same year, a domestic quarantine was promulgated by the Department of Agriculture for Canada. In 1928, both these quarantines were rescinded. Work will have to be continued in Quebec for some time, but it is to be hoped that many years may elapse before another situation such as the one found at Henrysburg, will have to be faced.

President T. J. Headlee: Next is a paper by M. D. Farrar and W. P. Flint.

REARING CODLING MOTH LARVAE THROUGHOUT THE YEAR (*CARPOCAPSA POMONELLA*)

By M. D. Farrar and W. P. Flint, *Natural History Survey Laboratory, Urbana, Ill.*

Abstract

It has been found possible to rear large numbers of codling moth larvae at any time during the year when larvae may be desired for laboratory tests. Larvae are collected from orchard trees by the usual banding methods. These are transferred to Mason jars containing a number of corrugated paper strips one-half inch wide and four to five inches in length. After the larvae have sought shelter in these strips they are placed in refrigeration or held outdoors at winter temperatures until spring and then placed in refrigeration at 50°F. and kept until needed.

When newly hatched larvae are desired, the corrugated strips are placed in black emergence jars in an incubator held at a temperature of 80–82°F. and humidity of

approximately 70°. The adults after emergence are transferred to special stone oviposition jars with moist sand in the bottom and lined with waxed paper and an apple is placed on the sand. These jars are covered with cheese cloth and held at the above temperatures and humidity in a light approximating that of summer twilight.

The adults readily oviposit on the paper on the sides and bottoms of these jars, or on apples placed in the jars, and have averaged about thirty eggs per female moth. After the papers are well covered with eggs they are cut into strips, placed in light proof tubes with a shell vial inserted in the side of the tube and held at ordinary room temperatures. The young larvae on hatching crawl into the vials and can then be readily transferred direct to the fruit.

By following these methods it has been found possible to secure large numbers of codling moth larvae at any time during the year when they are desired.

The rearing of a supply of young codling moth larvae at any time they may be wanted for use in insecticidal tests has been a problem since this type of work was started. It has always been easy to secure larvae during the summer months, at which time the adults oviposit readily under cage conditions. It is often desirable to conduct such laboratory tests at other times. A technique has been developed at this station by which larvae have been produced as desired and in sufficient numbers to make insecticidal tests profitable.

Source of Material: During the summer months bands are placed on promising trees in poorly kept orchards. At regular intervals these bands are examined and the larvae which have migrated to the bands are removed. The larvae are brought to the laboratory and allowed to spin up in corrugated paper cases. (Corrugated paper cut into one-half inch strips, either rolled or pasted, layer on layer.) About the same number of larvae as there are spaces in the strips are placed together, insuring the paper cases being well filled with larvae. If the larvae are to be carried over several months, the early ones must be held in cold storage until the temperature out-of-doors is low enough to stop pupation and emergence. The late season larvae are generally allowed to spin up out of doors. At Urbana, adults can be secured from such larvae about January 1st by bringing the larvae indoors. Before the larvae start to pupate in the spring, the entire lot is placed in cold storage at 50°F. and kept there until needed. It has been found best to carry over material to be used for fall and early winter tests from the previous year in this manner. Adults can be secured from such larvae in two or three weeks.

Emergence of Adults: Paper cases containing three hundred to five hundred larvae are placed in a two-quart Mason jar that has been previously painted black and closed with a screw cap into which has been

soldered a fine screen for ventilation. The moths emerging in the darkened jars remain quiet until removed. These jars are examined daily and such adult moths as have emerged are allowed to fly to a window screen, from which they are collected into a test tube and transferred to the oviposition jar.

OVIPOSITION JAR: For convenience in assembling, we used a specially designed jar seven inches deep and six and one-half inches, inside diameter, which was built by the Ceramics Department, University of Illinois. One-gallon stone jars may be used, however. The side walls are constructed vertically, tiny grooves are cut into the inside wall one and one-half inches from the bottom and one-fourth inch from the top.

PREPARATION OF JAR: About a one inch layer of moist sand is placed in the bottom and tamped smooth. Over this is placed a wax paper[1] disc, cut to fit snugly over the bottom. A strip of the same paper is cut to cover the side walls. To hold the paper snugly against the side walls, wire rings (cut from No. 14 iron wire) are inserted inside and adjusted to the grooves previously described. This method covers the bottom and side walls smoothly with wax paper and allows little chance for the moths to work themselves under the paper and die. An apple is placed in the jar and the top of the jar covered with a single thickness of cheese cloth, held in position with a rubber band. The jars are then ready for the adult codling moths.

About one hundred adults are generally used in each jar. The best results have been obtained where three to four jars are prepared at once and the daily emergence of adults distributed to these jars rather than placing all adults emerging on a single day into one jar. Adults may be added until the proper number are secured for the jar. The adults were left undisturbed until the first eggs blackened, indicating development, at which time the papers are removed, the jars thoroly cleaned and dried. Active adults in the jars at this time can be transferred to new jars. From twenty-five to thirty-five eggs per female moth was found to be a normal return from this method of handling.

OVIPOSITION CHAMBER: For good results an oviposition chamber is essential. Such a chamber should be constructed to hold a constant temperature. Our chamber is constructed of double wall Celotex with one side opening as a door. The chamber measures six feet by two feet by two feet inside dimensions. The heating is controlled by a mercury Thermostat, in combination with a battery and relay. The

[1]The wax paper used in the jars is of a very light weight grade, such as is used for wrapping foods. This paper is sold at most ten cent stores.

battery controls the relay which in turn switches on and off the 110 volt current. Three 110 volt heaters totalling about 150 watts are installed in the chamber as a source of heat. A water coil containing fifty feet of one-quarter inch copper tubing (through which tap water is circulated as desired) serves to reduce the temperature within the chamber whenever the room temperature goes above that in the chamber. The best results were secured with a temperature of 80–82°F. An open vessel of water is kept in the chamber which maintained a relative humidity of approximately 70°.

It was found essential to have a source of light in the oviposition chamber. The light should produce an approximate dusk within the chamber when the chamber is closed. We found that a low wattage, old style carbon filament lamp was very satisfactory. This gave only a perceptible glow in daylight, but produced a very effective oviposition light. This light was kept burning constantly and was the only source of light in the chamber.

Handling of Eggs: The moths deposit eggs on the paper covered side walls, the bottom and on the apple. When the first eggs blacken, the papers and apples are removed from the oviposition jars and placed in hatching tubes. These tubes were made from a standard six-inch paper mailing tube. By means of a cork borer a hole is cut in the side about one-third the distance from the top, into which is fitted a five-eighths by two and one-half inch shell vial. Before inserting the vial, the tubes should be dipped in melted paraffine to prevent loss of moisture from the interior. Four hatching tubes are used for each oviposition jar. The wax papers supporting the eggs were cut into strips about two inches wide and each strip loosely rolled and dropped into the bottom of the hatching tube. The apple is carefully peeled with a razor blade and the thin peelings distributed among the four tubes containing the papers. These peelings not only support eggs but serve as a source of moisture within the tubes. The mailing tube covers are screwed on and the tubes placed in a warm place with the vials toward a window. As the larvae hatch they will migrate to the shell vial as a source of light, in which they are easily seen. The shell vial can be withdrawn, the larvae removed with a camel's hair brush, and transferred directly to the fruit being tested. The shell vial is replaced until other larvae hatch. Practically all of the larvae will have hatched within ten days.

Vice-President F. N. Wallace assumed the Chair.

Vice-President F. N. Wallace: The next paper is by T. J. Headlee.

SOME SUBSTITUTES FOR ARSENIC IN CONTROL OF CODLING MOTH[1]

By THOMAS J. HEADLEE, Ph.D., *Entomologist*,[2] JOSEPH M. GINSBURG, Ph.D., *Biochemist in Entomology, New Jersey Agricultural Experiment Stations*, and ROBERT S. FILMER, B.S., *Research Assistant, Rutgers University*

INTRODUCTION

With the activity of Federal and State Pure Food officials in connection with arsenical residue on fruit, the question of substitutes for arsenic for control of codling moth in particular, and certain other insects in general, became of immediate importance to the fruit grower. In common with other fruit sections of the United States, New Jersey fruit growers have been made to feel strongly that something of this kind should be found. The reaction of some of the New Jersey Agricultural Experiment Station investigators to this need of the fruit grower has been to undertake serious studies in search for a substitute. Obviously such a substitute must be toxic to the codling moth and must be non-injurious or not seriously injurious to man.

Two materials have received consideration at the hands of the New Jersey Agricultural Experiment Station investigators, white oil impregnated with the extract of pyrethrum and a compound known as nicotine tannate.

WHITE-OIL-PYRETHRUM

The first field work began in 1927 with white oil alone on a two row block in the Robert Allen orchard at Glassboro. The two row block received the oil treatment and the data was taken from the selected trees in each of these two rows. One row on either side of this block was used as a check row. The check rows, of course, received the standard arsenical sprays. The trees in these blocks were large, varying from 20 to 25 feet in height.

Materials used and time of application are specified in Table 1 which shows that practically the same number of treatments were given with each kind of material.

[1]Paper of the Journal Series, New Jersey Agricultural Experiment Station, Department of Entomology.

[2]This investigation was planned and the paper has been written by the senior author.

The 1927 work was carried out by the senior author.

The 1928 work was carried out by the senior and by the second author.

The 1929 work was carried out by all authors jointly.

TABLE 1.

Oil Block	Spray Concerned	Standard Block
Nothing	Delayed Dormant	Lime-Sulfur (1–9) plus nicotine (1–500)
1.2 per cent White Oil	Pink Bud	Lime-Sulfur (1–40)
1.2 per cent White Oil + Powdered Lead Arsenate (3 lbs. to 100 gals.)	Blossom Fall	Lime-sulfur (1–40) plus Powdered Lead Arsenate (3 lbs.)
0.8 per cent White Oil	Ten-Days-After Blossom Fall	Dry-Mix (25 lbs.) plus Lead Arsenate (3 lbs. to 100 gals.)
0.8 per cent White Oil	First Cover Spray	Dry-Mix plus Lead Arsenate (4 lbs.) plus spreader (2 lbs.) to 100 gals.
Same as above	Second Cover Spray	Same as above
Same as above	Third Cover Spray	Same as above

During the season a certain amount of burning made its appearance on the foliage but could not be considered of any economic consequence. The June drop threw nearly twice as much fruit from the oil block as from the standard block, indicating that the oil had something to do with this drop. The season results are set forth in Table 2.

This table shows a codling moth injury of 15.8% more apples on the oil block than on the standard spray block. Up to September 23rd the codling moth control on the oil block ran neck-and-neck with that on the standard treated block. It seems to the investigator if an additional oil spray had been applied the results in codling moth control on the oil block would have been practically equal to the codling moth control on the standard block.

In 1928 four blocks of as many different standard varieties were placed under test in the orchard of Mr. Lester Collins near Moorestown. Oil treatments began with the first cover spray and three applications were made for the first brood. Rows on either side of each block were used as check rows and they received the standard cover spray of two applications for this brood. The oil material used in this case was a combination of oil and pyrethrum extract running at the rate of about three-fourths pound of flowers to one gallon of oil. The first cover spray application with oil carried an actual oil content of 1%. The succeeding two applications carried an actual oil content of 0.5%. Determination of infestation by first brood showed only a small infestation in either the standard treated blocks or the oil treated blocks. The infestation was a little less in the oil treated blocks than in the standard treated blocks.

Chlorosis made its appearance in the foliage of the Staymen block in about one week after treatment. The same thing occurred, but to a markedly less degree after the second treatment. No foliage injury traceable to oil made its appearance after the third spray. A heavy drop of fruit

TABLE 2. WHITE OIL VERSUS STANDARD SPRAYS IN CONTROL OF CODLING MOTH

Nature of Treatment	Row No.	Tree No.	Total Fruit	Sound Fruit	Per cent	Blossom	Shallow Side	Deep Side	Total	Curculio	Per cent Scab	Per cent B. Rot	Per cent Aphis	Per cent Crumpler
Standard........	2	1	4677	3332	71.2	10	1029	24	——	98	26	225	35	0
Standard	2	1	2655	1883	70.9	8	679	11	——	46	9	78	9	0
Standard	2	5	3044	2147	70.5	18	735	21	——	93	4	56	22	3
Standard........	2	3	2327	1517	65.1	9	722	15	——	34	7	78	5	1
Total Pick.......	–	–	12673	8879	——	45	3165	71	3281	271	46	437	71	4
Total Drop......	–	–	822	217	——	——	——	——	366	30	5	233	0	0
Grand Total	–	–	13495	9096	67.5	——	——	——	3647	301	51	670	71	4
White Oil.	4	1	2825	1514	53.5	87	861	69	——	86	57	296	64	30
White Oil........	3	3	1646	871	52.9	75	565	50	——	28	40	185	16	15
White Oil........	4	2	1927	1027	53.2	73	635	56	——	95	35	226	71	27
White Oil........	4	4	1950	977	50.1	107	646	74	——	28	47	235	28	17
Total Pick.......	–	–	8348	4438	——	342	2707	249	3298	237	179	942	179	89
Total Drop......	–	–	686	168	——	——	——	——	570	42	2	314	0	0
Grand Total. ...	–	–	9034	4606	50.9	——	——	——	3868	279	181	1256	179	89

Percentage of fruit in standard Block showing codling moth injury 27.0.
Percentage of fruit in oil Block showing codling moth injury 42.8.

TABLE 3. TABLE SHOWING EFFECT OF OIL-PYRETHRUM SPRAYS ON CODLING MOTH

Tree No.	Number of Apples Dropped	Number of Apples Picked	Number of Apples Total	Number of Apples Sound Dropped	Number of Apples Sound Picked	Sound Total	Percentage Sound	Codling Moth Injured Apples: Blossom End Drop	Blossom End Pick	Drop Side Drop	Drop Side Pick	Shallow Side Drop	Shallow Side Pick	Total Number	Injured %
Oil Sprays															
1	76	392	468	27	253	280		0.0		38		11		88	
2	68	313	381	40	249	289		2.0		22		4		92	
3	75	297	372	24	246	270		1.0		47		3		102	
4	26	339	365	17	252	269		2.0		15		2		96	
5	130	431	561	27	341	368		2.0		89		12		193	
Totals	375	1772	2147	135	1341	1476	68.7							671	
Average	75	354	429	27	268	295									
6		366			332										
7		248			215										
8		479			406										
Total picked fruit		2865			2294		80.0								
Standard Arsenical Sprays															
C1	136	409	545	31	215	246		0.0		94		11		299	
C2	74	258	332	26	158	184		3.0		35		5		148	
C3	19	150	169	9	90	99		0.0		9		1		70	
C4	73	337	410	23	136	159		1.0		45		7		251	
C5	128	617	745	37	355	392		1.0		69		6		353	
C1$_r$	178	437	615	47	288	335		4.0		114		13		280	
C2$_r$	93	295	388	28	218	246		2.0		60		3		142	
C3$_r$	52	189	241	20	115	135		1.0		24		7		106	
C4$_r$	41	100	141	27	82	109		0.0		8		6		32	
C5$_r$	65	321	386	13	209	222		1.0		42		9		164	
Totals	859	3113	3972	261	1866	2127	53.5	13.0		500		68		1845	46.5
Averages	85.9	313.3	397.2	26.1	186.6	212.7		1.3		50		6.8			
Picked fruit totals		3,113			1,866		59.9								

on all blocks was experienced. It can be said that the June drop on the oil block was approximately double what it was on the standard treated blocks. Treatments were discontinued because of this chlorosis and this drop. Attention was then turned to the possible cause of injury. Experiments on foliage penetration previously carried out were reviewed and much more extensive ones were undertaken. The net result was the conclusion that rate or speed of penetration varied inversely as the viscosity of the oil and the extent of penetration varied as the amount of oil retained upon the unit surface and that amount of chlorosis and fruit drop varied as the amount of oil deposited upon the unit surface. It is, of course, recognized that lower viscosity oils are preferred in dry sections of the United States but is. also known that such oils do not function as well in the heavily moist sections of which New Jersey is an example.

In 1929 a more thoroughgoing field study of this question was undertaken. A three row block of Winter Banana was set aside for treatment with oil. On either side of this block was one or more rows of Winter Banana of the same age and approximately the same size which were given the standard arsenical treatment. Experience in using white oils at one or more per cent had taught the investigators that such dosages were apt to produce chlorosis and induce fruit drop. The strength of oil used, therefore, in the 1929 studies was in all cases 0.5%.

The use of the oil pyrethrum was begun with the first cover spray for the first brood and continued throughout the period of entry by the larvae of the first and second broods. Furthermore, this material was applied, with the exception of four trees in one row, with a bean cluster nozzle instead of a spray gun and the writer thinks that he saw some evidence of injury on four trees that were gunned throughout this period.

Winter Banana was picked near the end of September. The data on the oil treatments were taken from five to eight selected trees in the middle row of the three row block. The data on the standard sprays were taken from selected trees in two rows, one on either side of the three row block. The results are set forth in Table 3. Unfortunately, through a misunderstanding, the distribution of different types of codling moth injury on the picked fruit was not determined in this study. Such distribution was determined, however, on the drops of the first five selected trees.

This table shows that 68.7% of the total fruit borne on the first five selected trees of the oil pyrethrum block was free from all types of codling moth injury as compared with 53.5% from the standard treated blocks, a gain of 15.2% in favor of the oil-pyrethrum treated block.

Disregarding all drop fruit and considering picked fruit only, including the total yield of the eight selected trees, this table shows 80.8% of all the picked fruit free from codling moth injury of all sorts on the oil pyrethrum block as compared with 59.9% derived in the same way from the standard treated block, a gain of 30% in clean fruit.

Nicotine Tannate Spray

Some three years or more ago Dr. Ginsburg, Biochemist in Entomology, New Jersey Agricultural Experiment Station, made up a number of compounds of nicotine with the thought of developing nicotine as a stomach poison. Among these compounds was one known as nicotine tannate which preliminary investigations soon revealed to have considerable toxic power as a stomach poison for certain caterpillars. In 1929 the attempt to put nicotine in the form of a stomach poison for insects was again taken up and nicotine tannate and nicotine silicotungstate were employed. Investigations on various insects showed that nicotine tannate had considerable merit as a stomach poison and it was deemed well to make a test of nicotine tannate against the codling moth.

By the time we were ready to use nicotine tannate against the codling moth it was time to begin cover spray for the second brood. Accordingly this material was used against the second brood. The combination known as nicotine tannate was made in the spray tank using three pounds of tannic acid and one pint of "Black Leaf 50" to one hundred gallons of water. We are reasonably sure that this combination leaves an excess of nicotine and an excess of acid. We were not quite sure whether this excess of acid was all gallic acid or whether it was partly tannic acid as well.

One row of good sized Ben Davis trees was set aside for this test and on either side were many rows of Ben Davis that received only the standard arsenical sprays.

The Ben Davis was picked in October and the results of the treatment are set forth in Table 4. The data were obtained from five selected trees in this row and from ten selected trees in the rows on either side of the nicotine tannate treated row.

This table shows 73.2% of the total fruit from the nicotine tannate treated row free from codling moth injury of all kinds as compared with 57.5% from the standard arsenical treated rows, a gain of 15.7% in favor of the nicotine tannate treated fruit. This table shows a little larger but practically the same gain on the part of the nicotine tannate treated rows when picked fruit alone is considered.

TABLE 4. SHOWING EFFECT OF NICOTINE-TANNATE SPRAYS ON CODLING MOTH.

Tree No.	Number of Apples Dropped	Number of Apples Picked	Number of Apples Total	Number of Apples Sound Dropped	Number of Apples Sound Picked	Number of Apples Sound Total	Percentage Sound	Codling Moth Injured Apples: Blossom End Drop	Blossom End Pick	Drop Side Drop	Drop Side Pick	Shallow Side Drop	Shallow Side Pick	Total Number	Injured %
Nicotine Tannate															
N1	306	1239	1545	207	809	1016		1.0	20	58	176	40	234		
N2	218	1421	1639	148	948	1096		1.0	7	47	159	22	307		
N3	334	1956	2290	240	1427	1667		0.0	2	74	141	20	386		
N4	377	1840	2217	299	1480	1779		0.0	1.0	49	132	29	227		
N5	124	1102	1226	90	881	971		0.0	0.0	20	46	14	170		
Totals	1359	7558	8917	984	5545	6529	73.2	2.0	30.0	248	654	125	1324	2388	26.8
Average															
Total picks		7558			5545		73.3								
Standard Arsenical Sprays															
C1	231	658	889	144	415	559		0.0	1.0	67	88	20	154		
C2	298	1257	1555	167	645	812		0.0	6.0	111	243	20	363		
C3	201	710	911	134	505	639		1.0	3.0	60	94	6	108		
C4	321	1065	1386	218	664	882		0.0	1.0	73	155	30	245		
C5	231	791	1022	172	502	674		1.0	1.0	33	81	20	207		
C1$_r$	215	957	1172	97	435	532		0.0	15.0	107	195	11	312		
C2$_r$	227	999	1226	121	455	576		0.0	10.0	92	209	14	355		
C3$_r$	180	1250	1430	105	701	806		0.0	2.0	61	190	14	357		
C4$_r$	197	1066	1263	133	631	764		0.0	4.0	47	126	17	305		
Totals	2101	8753	10854	1291	4953	6244	57.5	2.0	43.0	651	1381	152	2406	4606	42.5
Average															
Total picks		8753			4953		56.5								

TABLE 5. SHOWING THE COMPARATIVE TIME AND NUMBER OF SPRAY APPLICATIONS FOR PROTECTION OF APPLE DURING PERIODS OF ENTRY, 1929, BY CODLING MOTH.

Materials Used	Number of Applications: 1st Brood	2nd Brood	% Free from Codling Moth Injury: Total Fruit	Picked Fruit	Variety of Apple Concerned
White oil-pyrethrum	5/31, 6/11, 6/20	7/12, 7/22, 7/31, 8/9, 8/20	68.7	80.0	Winter Banana
Check	5/28, 6/17, 7/13		53.5	59.9	
Nicotine tannate		7/11, 7/22, 7/31, 8/9, 8/20, 9/8	73.2	73.3	Ben Davis
Check	5/28, 6/17, 7/13, 7/24		57.5	56.5	

Discussion and Conclusions

Of course the comparisons obtained in the field work of 1929 are much more thoroughgoing than those obtained in 1927 and 1928. There is little need to consider 1927 and 1928 except to say that those years show that when high viscosity white oil is used at greater than 0.5% a certain amount of cholorsis and a considerable amount of fruit drop is to be anticipated.

As a basis for discussing the comparative effectiveness of the standard arsenical sprays on the one hand and the white oil pyrethrum and nicotine tannate on the other hand, it is necessary to be familiar with the comparative number of treatments that were depended on to cover the period of entry by codling moth larvae of the first and second broodi Table 5 sets forth the facts relative to this matter.

In Winter Banana block the standard arsenical sprays covering this period numbered three, while in the Ben Davis block the sprays given with this material numbered four. In the oil the sprays covering this period numbered eight and when dealing with fruit picked in October might well require nine.

It is to be admitted at once, on the basis of these figures, that better control has been obtained through the use of the non-arsenical sprays than through the use of the standard arsenical sprays. It is likewise to be admitted at once that the amount of treatment necessary and consequently the incidental expense has been greatly increased. As balancing off this greater expense it should be pointed out that the fruit comes to maturity in a more handsome and attractive form and that the percentage of gain in clean fruit is large enough to pay the bill. Also as a matter of balancing off this additional expense it should be pointed out that there seems to be no reasonable reason to anticipate any necessity for spray residue removal.

There are certain factors that enter into the use of these sprays which will have to be further evaluated. The oil-pyrethrum spray increased the vegetative character of the trees, increased to a small extent the actual yield in fruit but decreases the size of the fruit buds for the following year. This may or may not be a serious matter. It might be advantageous in the long run or it might constitute a serious interference with fruit production over a period of years. The use of nicotine tannate for control of codling moth is so new thát it is difficult to foresee and unsafe to foretell what its effect upon production over a period of years would amount to. On the other hand nicotine tannate treated trees were as well protected from Japanese beetle as the standard arsenical

treated trees and furthermore the nicotine tannate treated trees were very largely protected from injury by late broods of leafhoppers. The writer thinks it can also safely be said that nicotine tannate can be made by other methods at a much lower cost than those that were employed in the field work this year.

From the preceding work, as set forth above, it may reasonably be concluded:

1. That either white-oil-pyrethrum or nicotine tannate can be employed for destruction of codling moth with as high a measure of control as can the arsenic sprays.
2. That these materials have in them the promise of reasonably and perhaps completely adequate substitutes for the control of codling moth in the place of arsenical sprays when used during the period of entry by the larvae of that insect.
3. That very considerable amounts of further work must be done upon them before they can be recommended for practical use.

VICE-PRESIDENT F. N. WALLACE: The next paper is by Anthony Spuler and Fred P. Dean.

NEW COMBINATION SPRAYS FOR CODLING MOTH CONTROL

By ANTHONY SPULER and FRED P. DEAN, *Washington Agriculture Experiment Station*

ABSTRACT

Lead arsenate is not an effective spray treatment for the second brood of the codling moth, *Carpocapsa pomonella*. From 40 to 50 per cent of worms placed on apples sprayed with lead arsenate 2-100 entered the fruit unpoisoned. The addition of mineral oils of medium to high viscosity to lead arsenate greatly improved the insecticidal value of the lead arsenate. This combination spray has an ovicidal value of 80 to 95 per cent and a larvicidal value much greater than that of lead arsenate alone. Fish-oil is even more effective than mineral oils in increasing the insecticidal value of lead arsenate. The nicotine-oil combinations have proved as effective as lead arsenate when applied in the cover sprays for the first brood and decidedly more effective if applied in the second brood sprays. All combination sprays of mineral oils with lead arsenate or nicotine sulfate are most effective if applied during the periods of maximum egg-laying. Because of cleaning difficulties, combinations of mineral or fish-oils with lead arsenate should be applied in first brood sprays and mineral oil-nicotine sulfate combination in second brood sprays.

The control of the codling moth under conditions experienced during the past season is a serious problem facing the fruit grower.

A combination of such factors as long continued activity of the codling moth (Fig. 1), optimum temperature conditions during second brood activity, difficulty of placing and maintaining a good arsenical spray covering on fruit when worms were most active were largely responsible for a heavy loss in fruit during the summer of 1929.

VALUE OF LEAD ARSENATE SPRAYS: Lead arsenate has long been the standard treatment for codling moth control, but much general dissatisfaction in its use alone has been reported by growers. A series of insectary tests during August in which a large number of newly hatched larvae were used showed that between 40 and 50 per cent of the worms placed on apples sprayed with lead arsenate 2–100 gained entrance without being poisoned. Chemical tests of apples so sprayed showed them to contain approximately 100 micro milligrams of arsenic per square inch of apple surface. At the same time chemical analyses of apples in orchards receiving six covers of lead arsenate showed 75 mmg. of arsenic per square inch ten days after the last spray.

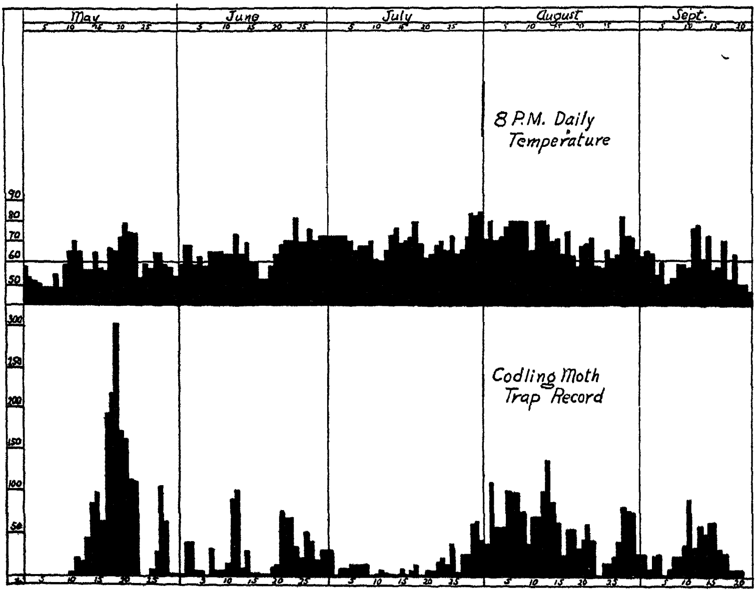


FIG. 1.—Moth activity during season of 1929.

The degree of control that can be expected in the use of lead arsenate alone depends on the uniformity of spray cover and on the amount of arsenical deposit on the fruit. Tests have shown that with the same arsenical deposit on the fruit, the type of cover that results in an even distribution of spray will give best results.

Lead arsenate when used alone places a spot type of cover on the fruit with little or no arsenical deposit between the spots. When a calcium caseinate spreader is added to lead arsenate, the spray spreads uniformly over the fruit. However, the addition of this spreader results in

a marked reduction in the amount of lead arsenate deposited on the fruit because of the heavy run off which it produces. This reduction in deposit more than offsets the advantages gained because of better coverage.

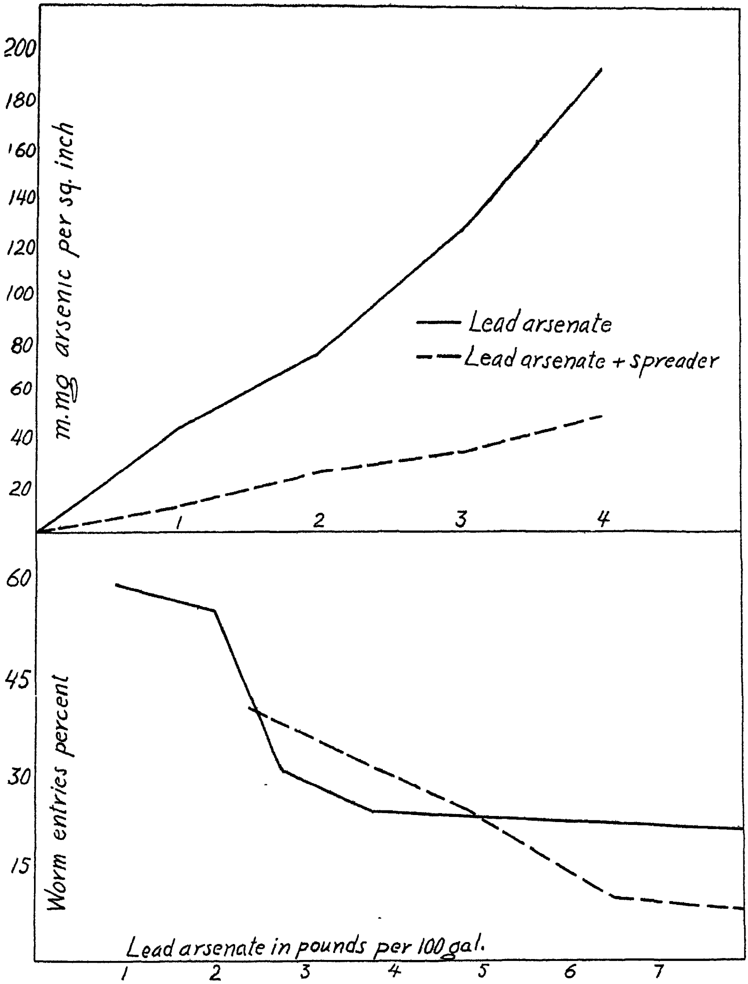


FIG. 2.—Relationship of lead arsenate concentration to arsenical load and control.

Increasing the strength of spray and thereby the deposit of lead arsenate on the fruit will result in increased control but this is not in direct proportion to the concentration of spray used. The results of increasing the dosage of lead arsenate in the spray are seen in Fig. 2.

It will be noted that control increases rapidly with concentration of spray until approximately three pounds of lead arsenate per 100 gallons are used after which added amounts of the arsenical have but little value. Twenty per cent of the worms, succeeded in entering the apple unharmed even after seven and one-half pounds of lead arsenate per 100 gallons were used.

Out of a large number of materials tried and discarded, a few combination sprays have consistently shown their superiority over lead arsenate used alone, especially for the control of the codling moth during the second brood. These sprays are combinations of mineral oil and lead arsenate, fish-oil and lead arsenate and mineral oils and nicotine sulfate.

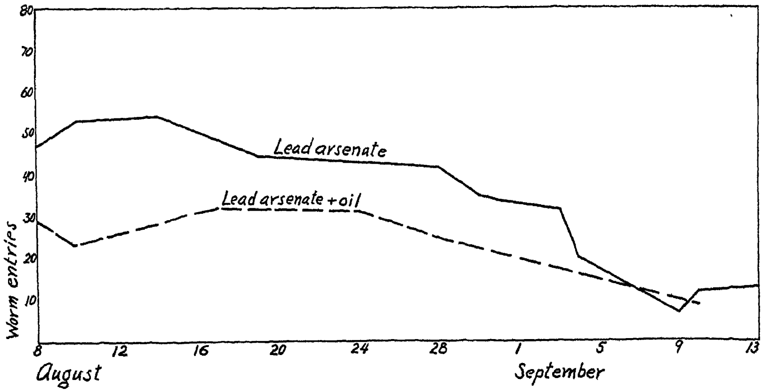


FIG. 3.—Larvicidal value of lead arsenate and oil-lead arsenate combinations.

MINERAL OIL AND LEAD ARSENATE COMBINATION: Highly refined mineral oils have been used in an experimental way for codling moth control for a number of years, but their use has not become general because information regarding the type of oil, strength of spray, effect on fruit and on residue removal has not until recently been available. Oils used in experimental work at Wenatchee, Washington, ranged in viscosity from 50 to 120 seconds Saybolt and in sulfonation test from 85 to 98%.

Insectary tests conducted by James Marshall in 1928 showed that mineral oils used at three-fourths per cent strength (actual oil) would kill from 80 to 95% of the codling moth eggs. He also found that the ovicidal value of the oil increased with the viscosity of the oil.

When oils are combined with lead arsenate, the resultant spray has an ovicidal value equal to that of oil alone and a larvicidal value greater than that of lead arsenate alone. Whether the increased larvicidal value is due to a more uniform coverage or to greater adhesive and elastic

properties or to a combination of all three factors has not been determined. The results of insectary tests on larvicidal value of lead arsenate and lead arsenate and oil combinations are given in Fig. 3.

In these tests the oil exerts no ovicidal value since the newly hatched worms were placed on the sprayed apples. It will be noted that the combination of oil and lead arsenate reduces the worm entry almost 40% over that of lead arsenate alone during August. As the season advances these differences decrease. The oil used in these tests had a viscosity of 72–75. Oils of 50 viscosity when combined with lead arsenate added very little to its larvicidal value. On the other hand, when an oil of 120 viscosity was added to lead arsenate, the resultant combination was very much more effective. The addition of an oil to lead arsenate increases the efficiency of lead arsenate over a longer period of time than when no oil is added, as shown in Fig. 4.

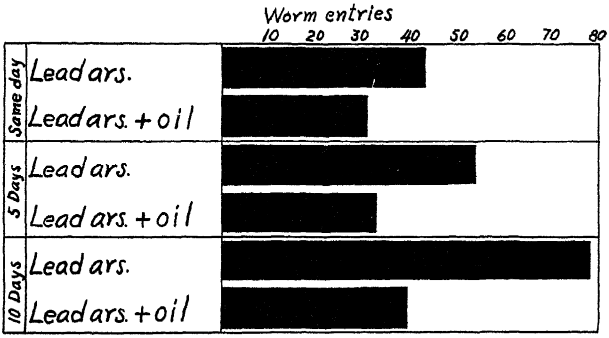


FIG. 4.—Effect of weathering and fruit growth on lead arsenate and oil-lead arsenate combinations.

Over 40 per cent of the larvae entered the fruit immediately after spraying, 55 per cent five days later and 78 per cent at the end of ten days. The oil-lead arsenate combination is more effective after ten days than lead arsenate alone is immediately after spraying.

From the standpoint of both ovicidal and larvicidal value the heavier oils are most effective. Since heavy oils have a tendency to injure fruit and complicate the washing problem, the selection of an oil for spray purposes should be made with the idea of getting one that is most effective in codling moth control, that can be used without injury to fruit and will not materially complicate the washing problem.

Since it is not advisable to use more than three applications of this combination spray during the season, they should be so timed as to be most effective. In order to determine when this combination is most

effective, a series of field tests were conducted in which a combination of lead arsenate 2–100 and an oil with a viscosity of 70–72 used at the rate one gallon of oil emulsion per 100 gallons was applied at different times during the season. The results of these tests are given in Fig. 5 and 6.

These results indicate that the combination is much more effective if used in the second brood sprays since plot number five in Fig. 5 which received two applications of this combination in the first two covers show a worm entry of 75 per 1000 apples while plot three in Fig. 6 with the same number of applications of this combination in the last two cover sprays shows a worm entry of only 22 per 1000 apples.

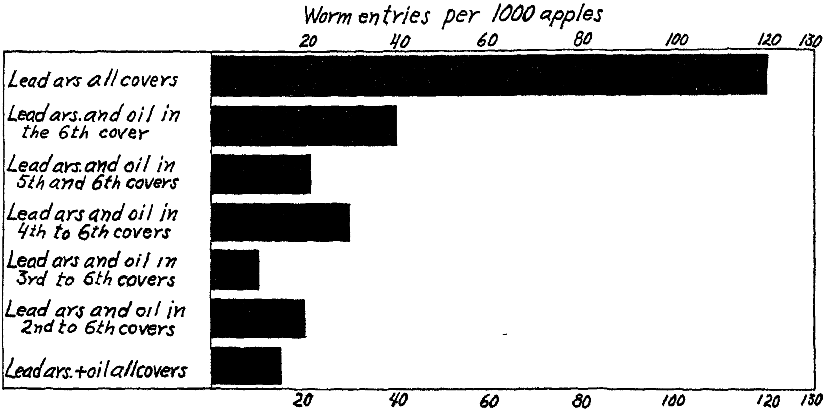


FIG. 5.—Relative value of oil in various cover sprays.

The results as given in Fig. 6 further show that the use of this combination spray in the first four cover sprays did not materially increase control over that obtained when the last two covers only received the lead arsenate-oil combination.

In another test the oil-lead arsenate combination was applied in the first and last covers only with excellent results. These are given in Fig. 7. In order to use a limited number of applications of this combination spray to best advantage it is imperative that moth traps be used to indicate the time that most of the eggs are laid in the orchard. In referring again to Fig. 1, it will be noted that most of the eggs in the first brood were laid between the 10th and 22nd of May and in the second brood between August 1st to 23rd. Combination sprays of oil and lead arsenate should be most effective if applied during this time. Results of field tests indicate that two sprays of oil combined with lead arsenate applied at this time reduced the worm infestation from 60 to 85% over that secured by the use of lead arsenate alone.

FISH-OIL AND LEAD ARSENATE: If a combination of mineral oil with lead arsenate increases the value of lead arsenate because of increased sticking or adhesive properties, even greater larvicidal value should result if a drying or semi-drying oil is used with lead arsenate, since drying or semi-drying oils have adhesive or sticking properties greater than that found in mineral oils.

The drying or semi-drying oils most commonly available are linseed oil (drying) fish-oil and corn-oil (semi-drying). In this group, fish-oil is perhaps the cheapest and most generally available. Its efficiency is somewhat less than linseed oil, but greater than corn-oil. In most of the insectary and field tests, fish-oil was used to determine the value of oils of this type in increasing the insecticidal value of lead arsenate.

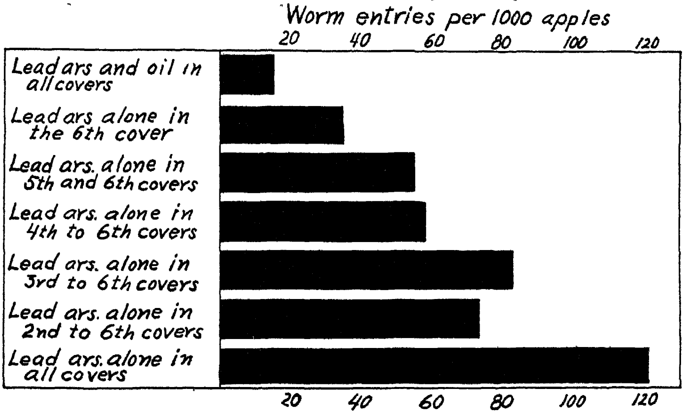


FIG. 6.—Relative value of lead arsenate and oil-lead arsenate in various cover sprays.

Field tests for the past three years have repeatedly shown that fish-oil combined with lead arsenate forms a spray that is much more effective than lead arsenate used alone. In these tests the fish-oil was not emulsified but poured into the tank of lead arsenate spray while the agitator was running. It was used at the rate of one quart of fish-oil to 100 gallons of spray.

Insectary tests show this combination to be more effective as a larvicide than the mineral oil-lead arsenate combination and field tests have shown during the past two years that fish-oil added to lead arsenate (1–100) is as effective as twice that amount of lead arsenate used alone.

This combination spray results in a heavy deposit of arsenical residue on the fruit. Because of the cleaning problem fish-oil should, therefore, not be used with large amounts of lead arsenate or in many applications.

MINERAL OIL AND NICOTINE SULFATE: Altho both nicotine sulfate and mineral oil have decided ovicidal value, the combination of the two adds but little to the ovicidal value of the oil used alone. However, the oil in this combination holds the nicotine sulfate on the fruit over a considerable period of time thus forming a spray combination that has both ovicidal and larvicidal value without depositing an objectionable residue on the fruit.

The combination of oil, one gallon per 100, and nicotine sulfate one-half pint to 100 gallons has given control of the codling moth equal to that of lead arsenate 2–100 in tests conducted the past two years. In

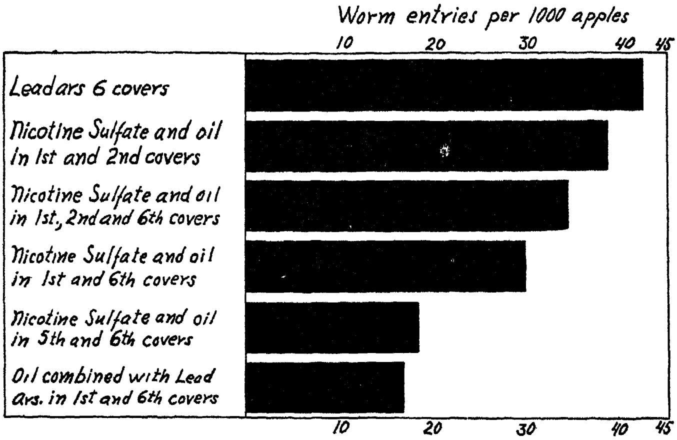


FIG. 7.—Value of combinations of medium oil ¾% actual oil and nicotine sulfate 1-1600 in various cover sprays.

addition to codling moth control this combination is effective in controlling such other pests as red spider, and green, rosy and woolly aphis.

However, as previously stated, oil sprays cannot be applied in more than three applications because of possible injury to plants. This also holds true for the oil and nicotine sulfate combination. This combination is also quite expensive and for that reason should be used in a limited way only.

In order to use this combination to the best advantage it should be applied in that part of the spray schedule where it is most effective. A series of field tests were conducted, in which this combination spray was used in various covers in the spray schedule. The results of these tests are given in Fig. 7.

These results show that this combination spray can be substituted for lead arsenate in any of the cover sprays with results equal to that of lead

arsenate used alone. They also indicate that if this spray is used during the height of the egg-laying period of both broods or in the second brood sprays, the control will be even better than where lead arsenate alone was used in all the covers.

Experimental tests during the past two years show that either of the three combinations discussed show a decided improvement over lead arsenate used alone. In addition to increased control of codling moth, the oil-nicotine sulfate and oil-lead arsenate combinations are a decided factor in the control of other insects as aphis, young scale, and red spider. None of the three combinations should be used thruout the entire spray program since they either complicate the cleaning problem or produce some injury to fruit. The oil-nicotine sulfate is most effective if used in the second brood sprays where it also seems to materially reduce the spray residue problem. The oil lead combination is most effective during height of the egg-laying period of both broods, but because it complicates removal if used in late sprays, it should be used in the first or second cover sprays. Fish-oil is not an ovicide at the strength used and is of value only in increasing the efficiency of lead arsenate. It can be used to great advantage in the early covers to keep the fruit protected.

President T. J. Headlee resumed the Chair.

MR. J. S. HOUSER: I should like to ask Mr. Spuler how he handles the fungicide problem with the oil spray.

MR. ANTHONY SPULER: We get practically no rain from the first time we start spraying until we harvest the fruit. The only thing we have to contend with at all is the mildew which only occurs occasionally, and we use the sulphur spray for that.

PRESIDENT T. J. HEADLEE: The next item is a paper by M. D. Leonard.

FURTHER EXPERIMENTS WITH NICOTINE-OIL FOR THE CONTROL OF THE CODLING MOTH IN THE PACIFIC NORTHWEST

By M. D. LEONARD, *Entomologist for the Tobacco By-Products & Chemical Corp., Louisville, Ky.*

ABSTRACT

Experiments conducted in the Pacific Northwest during the season of 1929 are reported on. These were in cooperation with several of the leading oil spray manufacturers. The resuts, in general seem to substantiate those obtained in 1927 and 1928, further indicating the value of the nicotine-oil combination in the general apple spray schedule in the Northwest.

Introduction

In the Journal of Economic Entomology, Vol. 22, pp. 72–77, 1929, there were reported upon by Frank B. Herbert, Entomologist for Balfour, Guthrie & Co., of San Francisco, California and the present writer experiments and experiences during the years 1927 and 1928 with the nicotine-oil combination for the control of the codling moth in the Pacific Northwest. The results were so encouraging that they have been continued during the season of 1929.

Extensive experiments with nicotine-oil and lead-oil were conducted in cooperation with the Washington State College under the direction of Dr. R. L. Webster and Prof. Anthony Spuler at Wenatchee, Washington. These will be reported on in detail in a separate paper by Prof. Spuler. Tests were also carried on with Mr. E. J. Newcomer of the United States Bureau of Entomology at Yakima, Washington; Prof. Claude Wakeland of the University of Idaho at Parma, Idaho; and with Prof. Don C. Mote of the Oregon State College at Corvallis, Oregon. Mr. Newcomer's results will be published later elsewhere. Professor Mote's and Professor Wakeland's complete data are not as yet available.

Because of the favorable results obtained last season with official workers and leading growers considerable interest has been aroused among oil spray manufacturers in the nicotine-oil combination for codling moth control. During the past season therefore, cooperative tests were conducted in the Wenatchee and Yakima Valleys of Washington with three of the leading oil spray companies. These were: Balfour, Guthrie & Co., under the direction of Frank B. Herbert, Entomologist and Mr. D. J. Chamberlin, Jr., Northwestern Representative; the California Spray Chemical Co., under the direction of Dr. W. S. Regan, Director of Research for the Northwest; and the Sherwin-Williams Co., under the direction of Mr. Harry E. White, Northwestern Representative. The work was done in five orchards representative of somewhat different conditions. It is the results chiefly of these tests which are here reported.

Originally this set of tests was planned to be on a commercial scale, using plots of at least two acres sprayed with each combination and a comparative pack-out to be taken from each plot at harvest time. It was not possible, however, to obtain a comparative pack-out of the fruit harvested and in two or three cases it was necessary to reduce the size of the plots. The chief purpose of the tests was to determine the control of codling moth to be obtained with nicotine and oil combined, as compared with arsenate of lead used alone and with arsenate of lead combined with oil.

Due to a steadily increasing codling moth infestation in these concentrated apple-growing sections of the Northwest and to the problem of arsenical residue removal, much attention has been given of late to developing a somewhat more efficient spray material than arsenate of lead alone, especially for second brood control. It is undoubtedly true that many growers are usually able to produce a commercially clean crop by the use of lead alone. To do so, however, requires a large number of cover sprays and an orchard either in a lightly infested district or one in which the infestation is at a fairly low ebb.

A combination of lead and highly refined summer oil emulsions has proved so successful that it has become very popular with growers, particularly for the mid- or late-season sprays. Orchard mites, such as the European red and the two-spotted mite are also checked at the same time. Such a schedule, however, has not simplified the removal of the arsenical residue which, although not usually unduly difficult or costly, constitutes, nevertheless, somewhat of a hardship to many growers. The necessity also still remains for making at least one or two additional applications for the control of such pests as rosy and green aphis, woolly aphis, San José scale (the summer "crawlers"), leaf hoppers, etc. The combination of nicotine and oil has proved about as efficient as the lead-oil for codling moth control, when used in the later applications. It has simplified the removal of arsenical residue and in some cases entirely done away with the necessity of washing the fruit. Also the coverage of the fruit and foliage obtained is excellent. The combination has also given good control of all of the other apple pests mentioned above.

Although the nicotine-oil is somewhat more costly than lead alone or even the lead-oil combination, it is believed that the extra expense is fully justified especially when it is considered from the standpoint of a multiple-purpose spray, which, if properly spaced in the ordinary spray schedule will satisfactorily handle the major apple pests present in the Northwest. It was planned to work out carefully comparative cost data on several of the tests this past season but unfortunately this did not prove to be practicable. It can be definitely stated, however, that it is the opinion of the various growers and experimenters concerned that the use of the nicotine-oil in the spray schedule for codling moth control fully justified itself and especially so when the control obtained of the other pests present was considered. It would seem that the nicotine-oil combination is most valuable in the later applications, lead alone or one or two lead-oil sprays in the earlier ones being more beneficial. The use of nicotine-oil in the last two cover-sprays, in a six

cover-spray area, figures only about one-half again as much as if lead only were used thruout and just the same as if lead alone were used in the calyx and second to fourth covers and lead-oil substituted in the first and last two covers. This is figuring 2 lbs. of lead, one gallon of oil, and one-half pint Black Leaf Forty in 100 gals. water at prevailing retail prices. If the additional cost of nicotine-oil and lead-oil be figured per box of apples on a normal crop at normal prices it is extremely small. This increased cost does not consider the saving from simplification of arsenical residue removal in the case of many growers and control of other pests besides codling moth.

In presenting the data obtained in the following five tests it should be pointed out that an attempt was made only to measure the control of codling moth. Due partly to a season of unusual worm activity, all of the comparisons are not as clear-cut as have been obtained in previous seasons. Moth emergence was not only more intensive but more prolonged than in several seasons past, the peak of second brood emergence coming almost the middle of August for the two Valleys. Local observers state that the past season has been one of the wormiest for a number of years. Most growers stopped spraying too soon and many orchards which were practically free from worm work up until mid-July or early August became badly infested later on with a large cullage showing in the packing house. The Ribbon Cliff, Villmann and Coffin orchards should have possibly each received one additional application. The protective influence of all spray material diminished as time went on and differences in worm control, quite apparent by looking over the plots earlier in the season, tended later to even themselves up.

Cooperative Experiments With Balfour, Guthrie & Company
Arthur Karr Ranch, Yakima, Washington

A five-acre plot was selected consisting of bearing Romes and Winesaps, each sprayed plot consisting of about one-half acre. Each plot received a calyx and five cover sprays, the calyx and first cover being lead in every case, with the combination sprays in the second to fourth covers. By mistake each plot received nicotine-oil in the fifth cover. This undoubtedly modified the final results obtained, since this last spray was timed to catch the peak of the second brood. The sprays were timed as carefully as possible based on moth emergence as determined by the use of bait pots in the orchard. They were made as follows: calyx—May 10th; first cover—May 28th; second cover—June 22nd; third cover—July 8th; fourth cover—July 29th; fifth cover—

August 15th. The fruit on four trees was examined in each plot except as otherwise noted.

Part of the remainder of Mr. Karr's orchard was sprayed on approximately the same dates as follows:

Calyx—Lead 2 lbs. and Spreaderex 4/5 lb. in 100 gals. water.
1st cover—Lead 2 lbs. and Medol 1¼ gal. and Spreaderex 4/5 lb.
2nd cover—As above.
3rd cover—Lead 1 lb. and Medol 1¼ gal. and Spreaderex 4/5 lb.
4th cover—Medol 1 gal. and BL40 2/5 pt. and Silque 4/5 lb.
5th cover—As above but no spreader.

This schedule is referred to as the "Orchard Treatment" in the following table and was compared directly with our experimental plots.

It is interesting to note that on Mr. Karr's 25 acre pear and apple ranch at Tieton, Washington, in the upper Yakima Valley where worm infestation is somewhat lighter normally, he used a calyx and the first and second covers as above. The third cover, with nicotine-oil, however, was the last and fifty-five days elapsed between it and the second cover. Mr. Karr stated that his worm control was highly satisfactory—the best he has ever had—whereas adjoining or near neighbors with similar orchard conditions but a different spray schedule suffered severe cullage from worm work.

TABLE 1. SUMMARY OF RESULTS ON THE ARTHUR KARR RANCH, YAKIMA, WASH.

Treatment per 100 Gals.	Total No. Apples	% Wormy	% Stung	% Wormy and Stung
Romes				
Lead[1]	3689	12.4	11.1	23.5
Lead and Spreader[2]	4220	18.4	9.8	28.2
Lead and Medol, 1¼ gal. and Spreader	5765	8.3	6.7	15.0
Nicona, 1¼ gal	4185	17.3	14.5	31.8
Black Leaf 40, ½ pt. and Medol[3] 1¼ gal	2846	8.8	5.1	13.9
Black Leaf 40, ¾ pt. and Medol, 1¼ gal	3635	8.1	6.8	14.2
Orchard Treatment (3 trees)	2572	6.6	5.5	12.1
Winesaps				
Lead (3 trees)	2982	13.4	11.6	25.0
Lead and Spreader	4652	6.3	8.7	15.0
Lead and Medol, 1¼ gal. and Spreader	4447	3.5	4.6	8.1
Nicona, 1¼ gal	4283	7.5	9.7	17.2
Black Leaf 40, ½ pt. and Medol. 1¼ gal	4462	2.0	2.9	4.9
Black Leaf 40, ¾ pt. and Medol, 1¼ gal	5457	2.3	4.3	6.6
Orchard Treatment	5111	1.7	3.6	5.3

[1]Arsenate of Lead was used each time at the rate of 2 lbs. in 100 gals. of water.
[2]Spreaderex 4/5 lb., but Silque 4/5 lb. in 4th cover.
[3]Medol is an oil emulsion manufactured by Balfour, Guthrie & Co.—viscosity—65 Secs; sulfonation test 92–94; % oil 79–82.

It will be noted from an examination of Table 1 that Mr. Karr's regular orchard treatment, which was compared with the experimental plots, gave as good if not slightly better worm control than any of the others. The Black Leaf 40-oil plots were a close second, with the lead-oil next on both Winesaps and Romes. Lead alone was by far the least effective especially on Winesaps and on Romes, the spreader apparently decreased even its efficiency. However, Nicona, a nicotine-oil preparation manufactured by Balfour, Guthrie & Co., guaranteeing at least 1% actual nicotine, gave about the same control as lead and spreader on both varieties. In all fairness it should be stated that the Nicona plot was located nearest the orchard buildings, therefore undoubtedly did not have as good a chance as the other plots. This material was put on the market in only a limited way during the past season. Next year it is planned to considerably increase its nicotine content which should greatly improve its efficiency. Strangely enough no better control of worms was obtained by using Black Leaf 40 at ¾ pt. to 100 gals. with oil than with ½ pt. This was undoubtedly due to experimental error. As previously suggested, more striking differences would undoubtedly have shown up had not the last cover in all plots been made with nicotine-oil alone since this was the most important spray for the control of the second brood.

Ribbon Cliff Ranch, Entiat, Washington

An attempt was here made to compare lead, lead-oil and nicotine-oil, again using Nicona and two strengths of Black Leaf 40. No spreader was used. Plots of approximately two acres each were selected in a 70-acre orchard, including a half dozen commercial varieties. Counts were made only on Delicious and Winesaps. A calyx and three covers were applied, which is normally sufficient for the Entiat section, but this season at least one more cover would have given better control on varieties such as Winter Bananas, Jonathan and Delicious. Dates of application were as follows: calyx, April 29; first cover, May 20–24; second cover, June 4–6; third cover, June 20–24. Arsenate of lead alone was used in the calyx and first cover, the combination sprays being in the second and third only.

Table 2 summarizes the results obtained, based on an examination of all the apples from each of four trees in each plot on each variety at harvest time.

All treatments apparently gave almost equally very good control on the Winesaps. On the Delicious, ¾ pt. of Black Leaf 40 with oil was the best, with Nicona showing the highest percentage of worms.

TABLE 2. SUMMARY OF RESULTS ON THE RIBBON CLIFF RANCH, ENTIAT, WASH.

Treatment per 100 gals.	Total No. Apples	% Wormy	% Stung	% Wormy and Stung
Delicious				
Lead[1]	4891	10.8	6.2	17.0
Lead and Medol 1¼ gals	4619	9.7	4.0	13.7
Nicona 1¼ gals	3443	19.9	3.6	23.5
Black Leaf 40 ½ pt. and Medol 1¼ gals	3185	12.0	4.0	16.0
Black Leaf 40 ¾ pt. and Medol 1¼ gals	3080	7.3	2.7	10.0
Winesaps				
Lead	2719	1.5	3.6	5.1
Lead and Medol 1¼ gals	4361	2.4	3.1	5.1
Nicona 1¼ gals	1646	3.6	2.9	6.5
Black Leaf 40 ½ pt. and Medol 1¼ gals	3550	2.0	2.4	4.4
Black Leaf 40 ¾ pt. and Medol 1¼ gals	3447	2.1	2.2	4.3

[1]Lead was used each time at the rate of 2 lbs. in 100 gals. of water.

C. R. Villmann Ranch, Wapato, Washington

Mr. Villmann had such excellent results in codling moth control in 1928 with nicotine and oil on 2½ acre plots as compared with lead alone that this past year he decided to spray approximately sixty acres of his eighty acre orchard with nicotine-oil and the remainder with lead. A calyx and four cover sprays were applied with lead and Fluxit[1] spreader in the calyx and first cover throughout the orchard and the nicotine-oil with the spreader in the second, third, and fourth covers on the sixty acre section. The dates of applications in the section in which count trees were selected follow: calyx, May 11–13; first cover, May 18–21; second cover, May 29–31; third cover, June 14–22; fourth cover, July 15.

TABLE 3. SUMMARY OF RESULTS OF C. R. VILLMANN RANCH, WAPATO, WASH.

Treatment per 100 gals.	Total No. Apples	% Wormy	% Stung	% Wormy and Stung
Jonathan				
Lead (6 trees)	3299	16.0	3.1	19.1
Black Leaf 40 ¾ pt. and Medol L. ¾ gal. (6 trees)	3781	11.2	2.1	13.3
Winesap				
Lead (6 trees)	6303	2.3	4.2	6.5
Black Leaf 40 ¾ pt. and Medol L. ¾ gal. (7 trees)	11509	5.8	4.8	10.6

It would appear from a summary of the results in Table 3 that although worm control was almost 50% better with nicotine-oil than with lead on the Jonathans, there were twice as many wormy apples and just

[1]Fluxite is a highly colloidal insecticide fixator, not to be confused with the popular term "spreader" (calcium caseinate). It is manufactured by the Colloidal Products Corp. of San Francisco, Calif.

as many stung ones where the Winesaps were sprayed with nicotine-oil as with arsenate of lead. These figures can hardly be taken at their face value, however. Mr. Villmann states that the section of his ranch in which the lead sprayed Winesaps are located has always been the cleanest part of the orchard. Due to considerably varying conditions throughout a sixty acre tract the selection of only seven count trees which would truly represent actual worm conditions in the whole tract was almost impossible. Due to this fact coupled with a certain amount of experimental error in taking results, Mr. Villmann feels that the actual percentage of wormy fruit was probably almost the same with each treatment, but nevertheless, both figures (2.3% and 5.8%) represent good worm control for this season.

Although a comparative pack-out of all the apples on each treatment could not be arranged, due to lack of time at harvest, some figures were obtained. In what Mr. Villmann designates as his "East 20-acre tract," about twenty trees sprayed with arsenate of lead and Fluxit were only 6% wormy, but had a total of 31% culls due to rosy aphis injury. Altho twenty comparable trees in the tract immediately adjoining which was sprayed with nicotine-oil and Fluxit, showed about 11% wormy apples, they had only a total of 16% culls due to good aphis control. Mr. Villmann feels this is very satisfactory for this past season of rather unusual worm work, especially since the cost of an additional application was saved. Had extra applications for aphis control been made on the lead tracts, as should have been done, additional expense would have been incurred. Mr. Villmann plans to spray his whole orchard with nicotine-oil next season in the last two or three applications and eliminate the cost of washing the fruit. This past season the nicotine-oil sprayed apples were washed only with clear water to remove dust.

Cooperative Experiment With the California Spray Chemical Company

Ted Hackett Ranch in the Broadway District, Yakima, Wash.

The spraying on the experimental plots on this ranch was done personally by Dr. Regan of the California Spray Chemical Co., and an assistant. The applications were carefully timed by means of bait-pots for the moths.

Each plot received six applications made on the following dates: May 19; May 31; June 15; June 28; July 11; August 6. Jonathans were picked September 20th; Delicious and Romes October 3rd; Winesaps October 15th.

TABLE 4. SUMMARY OF RESULTS ON THE BROADWAY DISTRICT RANCH, YAKIMA, WASH.

Plot No.	Variety	Treatment per 100 gals. Water	Apples Total No.	% Wormy and Stung	% Culls
1	Rome	Lead[1]	820	46.2	33.2
7-B	Rome	Lead and Orthol-K medium,[2] no spreader	794	13.0	7.4
8	Delicious	Lead and hydrated lime, 1 lb. and Orthol-K medium	487	3.2	1.4
	Winesap	Lead and hydrated lime, 1 lb. and Orthol-K medium	1235	2.5	1.0
9	Delicious	Lead and hydrated lime, ½ lb. and Orthol-K medium in 1st 3 appl., then Orthol-K med. and BL40, ¾ pt. in 3 appl.	855	10.1	13.8
	Winesap	Lead and hydrated lime, ½ lb. and Orthol-K medium in 1st 3 appl., then Orthol-K med. and BL40, ¾ pt. in 3 appl.	151	12.5	9.9
10	Delicious	As above, except BL40, 1 pt. and lead-oil and lime in 1st and 2nd appl. only............	603	8.6	6.4
	Winesap	As above, except BL40, 1 pt. and lead-oil and lime in 1st and 2nd appl. only	161	7.4	7.4

[1]Arsenate of lead was used each time at the rate of 2 lbs. in 100 gallons water.
[2]Orthol-K medium oil was used each time at the rate of ¾ gal. in 100 gallons of water. This oil has a viscosity of 80 Secs., sulfonation test of 92–94 and contains 83% oil.

As an indication of the infestation in the test orchard, it might be mentioned that a total of 5574 codling moths were caught in six bait pots in an adjoining portion of the orchard (about 100 yards away from the test block), between May 11 and October 1. The unsprayed check tree thinned at ten day intervals for stings and worms throughout the season, had only 157 apples on the tree at picking time, out of a total of 995 on the tree originally free from worm work. This tree was located among well-sprayed trees and at each thinning all infested fruit was checked and destroyed. A total of 615 side worms, 138 stings and 260 calyx worms were found on this unsprayed Winesap during the season. This tree and all of the trees in the test block were banded, the bands gone over every ten days and worms under them destroyed.

It will be noted from Table 4 that Plot 9 received three applications of lead-oil followed by three of nicotine-oil whereas Plot 10 had nicotine-oil in the last four sprays and double the amount of nicotine. The additional application in Plot 10 reduced somewhat the percentage of total worm work on Delicious and to nearly one-half on Winesaps while the total cullage from worm work was reduced somewhat on Winesaps but to one-half on Delicious. The control on both of these nicotine-oil

plots was greatly superior to that with lead alone even though the latter was on Romes, a normally more susceptible variety than either Delicious or Saps.

Plot 7-B with lead-oil in all sprays was undoubtedly no better if quite as good, as the two nicotine plots when it is considered that it consisted of Romes.

The addition of hydrated lime to the lead-oil in Plot 9 gave surprisingly clean fruit. However a considerable arsenical residue and little control of aphis should be considered when judging the full merits of such a treatment.

Cooperative Experiment With the Sherwin-Williams Company

Coffin Orchard, Sawyer, Wash.

The work here was carried on in a 100-acre bearing orchard. Bartlett pears and Jonathan and Winesap apples were included. Lead alone, lead and oils of several types and concentrations, and Black Leaf 40 and oil were compared. The experimental section included about three acres and each plot consisted of 10–12 apples interplanted with 10–12 pear trees. Sawyer is in the lower Yakima Valley and in the center of one of the most severe codling moth areas in the Northwest. Many growers in the vicinity applied this season eight to ten cover sprays on Jonathans with highly unsatisfactory worm control. Mr. White of the Sherwin-Williams Co., personally did the spraying in the experimental plots, timing the applications by the use of bait pots. A calyx and seven covers were given but even then an additional spray should possibly have been made, especially on Jonathans. The spray dates follow: calyx, May 3; first cover, May 15; second cover, May 30; third cover, June 11; fourth cover, June 24; fifth cover, July 8; sixth cover, July 23, seventh cover, August 5th. In each plot where oil-lead was used the combination was made only in the second, fourth and seventh covers, arsenate of lead alone being applied in the remainder. In plot 8 the nicotine-oil was used in the second to seventh covers and without a spreader. All other plots had ¼ lb. of Kaso spreader per 100 gals. water except where oil-lead was used when Kayso was raised to ½ lb.

Table 5 shows very good control from all treatments in Bartlett pears, although the actual figures show lead to be the poorest, lead-oil next best and nicotine-oil the best. The Jonathan apples were heavily infested in the lead plot, lead-oil reducing the total worm work to almost

one-half and the nicotine-oil to one-third. All plots of Winesaps, except lead alone and nicotine-oil show 1% or less wormy apples and here the lead is only 2.4%.

TABLE 5. SUMMARY OF RESULTS ON THE COFFIN ORCHARD, SAWYER, WASH.

Plot No.	Treatment per 100 gals.	Total No. Apples	% Wormy	% Stung	% Wormy and Stung
		Bartlett Pears			
5	Lead (3 trees)[1]	1580	3.3	6.8	10.1
7	Lead and Med. Oil,[2] 1 gal. in 2nd, 4th and 7th covers (9 trees)	3268	1.8	2.6	4.4
8	Black Leaf 40, ¾ pt. and Med. Oil, 1 gal. in last 6 covers (5 trees)	3268	0.9	2.5	3.4
10	Med. Oil, ¾ gal. and lead	3578	2.9	3.3	6.2
		Jonathan Apples			
5	Lead (4 trees)	5099	25.7	18.8	44.5
6	Light Oil[3], 1 gal. and Lead (4 trees)	4356	13.8	11.9	25.7
8	Black Leaf 40, ¾ pt. and Med. Oil, 1 gal. (3 trees)	2681	9.8	4.4	14.2
		Winesap Apples			
2	Lead and Med. Oil, 1¼ gal. (3 trees)	5682	0.3	6.3	6.9
3	Lead and Med. Oil, 1½ gal. (5 trees)	7083	0.8	6.7	7.5
4	Lead and Light Oil, 1½ gal. (4 trees)	4083	0.7	14.2	14.9
5	Lead (5 trees)	7197	2.4	26.5	28.9
6	Lead & Light Oil, 1 gal. (4 trees)	7689	0.9	16.2	17.1
7	Lead and Med. Oil, 1 gal. (6 trees)	7101	0.7	14.0	14.7
8	Black Leaf 40, ¾ pt. and Med. Oil, 1 gal. (3 trees)	4049	2.4	6.1	8.5
9	Lead and Light Oil, 1¼ gal. (5 trees)	7688	0.8	14.1	14.9
10	Lead and Med. Oil, ¾ gal. (4 trees)	6521	1.0	16.8	17.8

[1]Lead was used each time at rate of 2-2/3 lbs. in 100 gals. water.
[2]The medium oil used was Sherwin-Williams' Summer Mulsion Medium-viscosity 72 Secs; sulfonation test 92%; oil content 83%.
[3]The light oil used was Sherwin-Williams' Summer Mulsion Light-viscosity 52 Secs; sulfonation test 92%; oil content 83%.

COOPERATIVE EXPERIMENT WITH THE WASHINGTON STATE COLLEGE AT WENATCHEE, WASH.

As supporting data for the five cooperative tests with oil spray manufacturers, Prof. Spuler has kindly permitted the inclusion of a chart, given here as Fig. 8. Although it summarizes the results of only a part of Prof. Spuler's work during the past season in comparing lead, lead-oil and nicotine-oil for codling moth control, it undoubtedly brings out in the briefest manner the most important results obtained.

This chart represents graphically the number of codling moth worms in each 1000 apples when lead alone, lead and oil combined, and nicotine-sulphate and oil combined were used in the spray schedule. A calyx and six cover sprays were applied to each plot, lead alone being used where the combination sprays are not indicated. The plots were located in the State College experimental orchard at Wenatchee. The variety was Jonathan apples. Lead, 2 lbs; Standard Oil No. 6, ¾% actual oil (1% emulsion) and nicotine-sulphate (Black Leaf 40), ½ pt., each to 100 gals. of water.

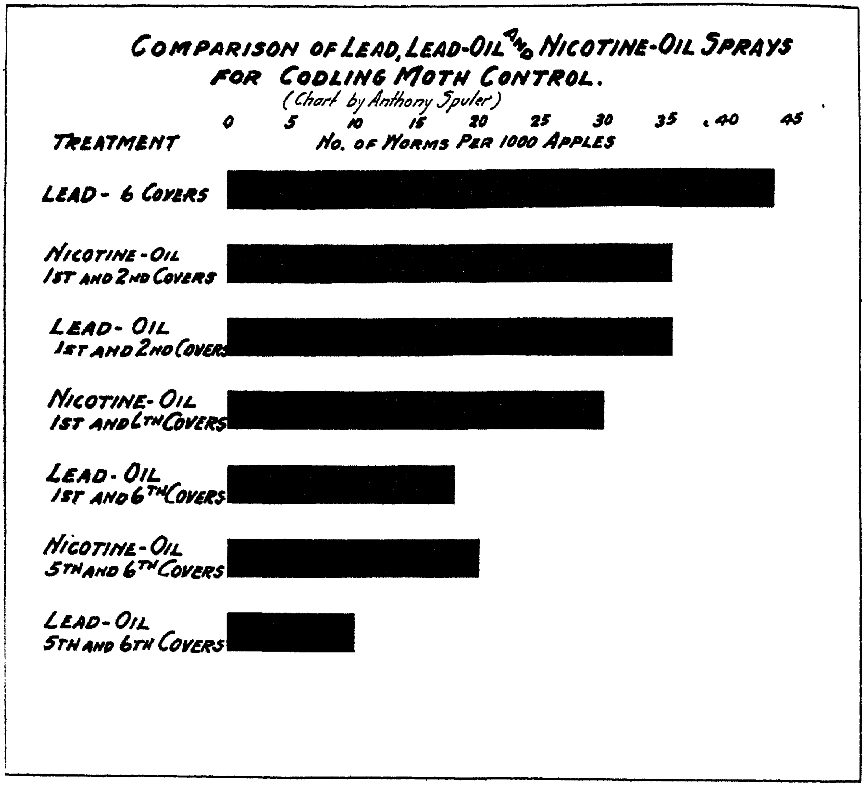


FIG. 8.—Codling moth data obtained at Wenatchee, Wash.

The above table shows conclusively that either oil added to lead arsenate or the nicotine and oil substituted for the lead gives somewhat to considerably better worm control than a straight schedule of lead alone. Lead or lead and oil is much more beneficial when used in the earlier covers for first brood control and the nicotine and oil more so in the late covers for second brood control. Although the lead-oil gave

twice as good worm control when used in the last two covers as did the nicotine-oil the amount of arsenical residue present was considerable. It is felt, therefore, that the nicotine-oil product is by far the more practical of the two.

Nicotine Analyses

An attempt was made to determine the amount of nicotine deposited upon sprayed trees when combined with oil emulsions and the length of time the nicotine persisted. Because of easier handling, foliage rather than fruit was used. Four hundred leaves were collected each time from each of nine plots in Professor Spuler's experimental orchard at Wenatchee. These were placed at once in air-tight tins and shipped to Richmond, Va., for analysis by Mr. R. B. Arnold, Chief Research Chemist for the Tobacco By-Products & Chemical Corporation. The samples were taken at intervals of one or two days and a week to ten days after each application and the amount of nicotine present determined quantitatively. This is the first time, to the writer's knowledge that such analyses have been attempted. Due to several possible variations, especially in taking the samples, the results were not entirely conclusive. Without going into the several details of the spray schedules used, dates of applications, temperatures, etc., it may be stated that some building up of the nicotine residues occurred after two or more sprays in succession. This was particularly apparent from the time of the fourth cover spray (made July 1) thru the fifth cover and sixth (final) cover. Analyses made on several of the plots at four intervals following the final spray then clearly showed the gradual dissipation of the nicotine residues in a thirty-one day period.

Previous laboratory experiments carried out by Mr. Arnold showed that when Black Leaf 40 was mixed with summer oil emulsions the nicotine persisted for an appreciably longer time than when it was used alone. More work should be done along the line of nicotine residues as a check on control obtained and upon methods for holding the nicotine on the tree for a longer period.

Conclusions

All those involved in the carrying out and in the interpretation, based on knowledge of actual conditions, of the above five tests feel that the results obtained with the nicotine-oil combination were satisfactory from the standpoint of pest control. These results substantially duplicate those obtained during the two previous seasons. In making

this statement, it should be borne in mind that the tests this past season were made rather on a commercial scale than on a strictly small test-plot basis, that the season was one of unusually severe worm activity and that in several of the tests spraying was possibly stopped too soon.

Although codling moth was the most important factor in all but one or possibly two of the orchards used, other pests, especially rosy aphis and orchard mites were a considerable factor in the final pack-out and consequently in the net returns received by the grower. It was felt by the owner of each orchard that the nicotine-oil combination more than justified its use.

Considering also the strictly comparative results obtained by official workers, such as Mr. Newcomer and Prof. Spuler during the past season, as well as the experience of practical growers, it should be stated that nicotine-oil undoubtedly gives considerably better results when used only in the last two or three covers than when used in all cover sprays or in the early ones only. It would seem that it would be best for most growers to start the season with a spray or two of lead, followed by an application or two of lead-oil, completing the schedule with two or possibly three of nicotine-oil. Such a schedule would of course have to be modified somewhat to fit local conditions. It would seem, however, from present indications, to be the most efficient for the control, not only of worms and stings and the other major apple pests, but also the most economical from the standpoint of net returns to the grower. In the future, the trend of further experimental work in the Northwest will undoubtedly be along the line of such a combined spray schedule and it is expected that many more growers will adopt a lead, lead-oil, nicotine-oil schedule next season.

MR. J. J. DAVIS: May I ask the percentage of nicotine used?

MR. M. D. LEONARD: In most cases, one-half a pint of Black Leaf 40 per 100 gallons; in some cases, three-quarters of a pint. There is some evidence to show that where the nicotine is increased in strength you might expect a little better control, but apparently where used in standard brands of summer oils approved by growers in the Northwest a half pint of Black Leaf 40 will do it. That is all we use except one commercial nicotine oil spray. The oil apparently tends to tie up the nicotine and slow down its action, and hold it there over a long period.

MR. R. H. SMITH: I would like to ask what results have been obtained in using algaenate, glycerin and Karo syrup with nicotine sulphate for the purpose of reducing the volatility of the nicotine.

MR. M. D. LEONARD: We experimented in cooperation with Professor Spuler on nicotine and glycerin, and nicotine and Karo syrup. Preliminary experiments showed that Karo syrup and glycerin particularly tied up the nicotine very tightly. It slowed it down very considerably. We thought the nicotine film would remain over a long period, but the effect on fruit was such that it was not so good, and I think commercially that it can be forgotten. Mr. Newcomer had some tests with that.

The nicotine algaenate didn't pan out quite so well in the control as far as I can remember. In other words, although we tried nicotine and sugar, nicotine algaenate with Karo syrup, and so forth, we have come to think that the practical mixture is with the summer oil.

PRESIDENT T. J. HEADLEE: The next paper is by R. B. Neiswander and L. A. Stearns.

CERTAIN FACTORS INFLUENCING ORIENTAL FRUIT MOTH INFESTATION

By R. B. NEISWANDER and L. A. STEARNS

ABSTRACT

Statistical interpretation of data accumulated in experimental orchard spraying in Ohio during 1929 for control of the Oriental Fruit Moth (*Laspeyresia molesta* Busck) indicates that peach tree vigor as evidenced by twig length and weight is distinctly correlated with the number and per cent of injured twigs; furthermore, that a similar correlation exists between total fruit and the number and per cent of visibly injured fruit. Such influencing factors should be given adequate consideration in planning and in evaluating the results of control endeavors.

While recording Oriental Fruit Moth injury to peach twigs during the past two seasons it has been observed that trees in a high state of vigor seemed to be more severely injured than slowly growing trees. This suggested the possibility that growth conditions might influence decidedly the degree of injury and thus affect the results obtained from different insecticides if varying growth conditions exist among experimental plots. It seemed desirable, therefore, to make linear and weight measurements of twigs of the current season's growth in order to determine a possible correlation between vigor and Fruit Moth injury.

In experimental orchard spraying during the season of 1929, 20 half-acre plots of the Elberta variety were treated with different combinations of hydrated lime and other insecticides. One plot in this series, which showed representative variation in the number of injured twigs per tree as well as in the degree of vigor of the several trees of the plot, was selected for a study of the correlation of vigor with injury. The

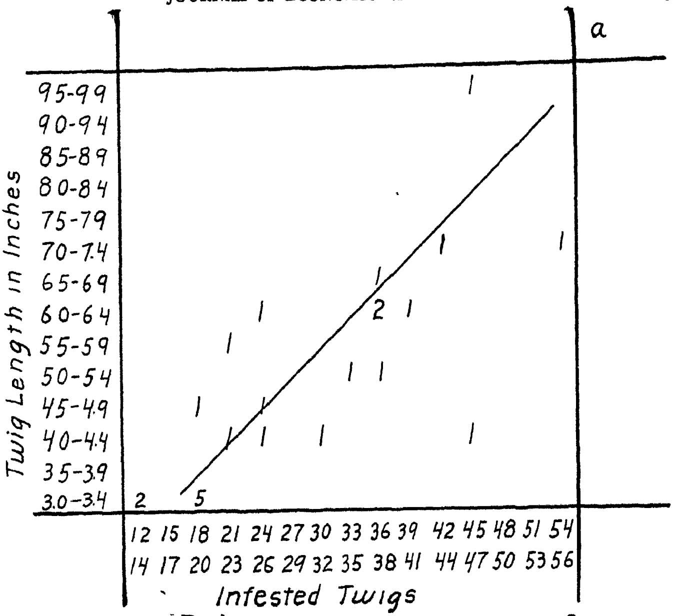

a
Twig Length in Inches
95-99
90-94
85-89
80-84
75-79
70-7.4
65-69
60-64
55-59
50-54
45-4.9
40-4.4
35-3.9
3.0-3.4
12 15 18 21 24 27 30 33 36 39 42 45 48 51 54
14 17 20 23 26 29 32 35 38 41 44 47 50 53 56
Infested Twigs

FIG.-9.

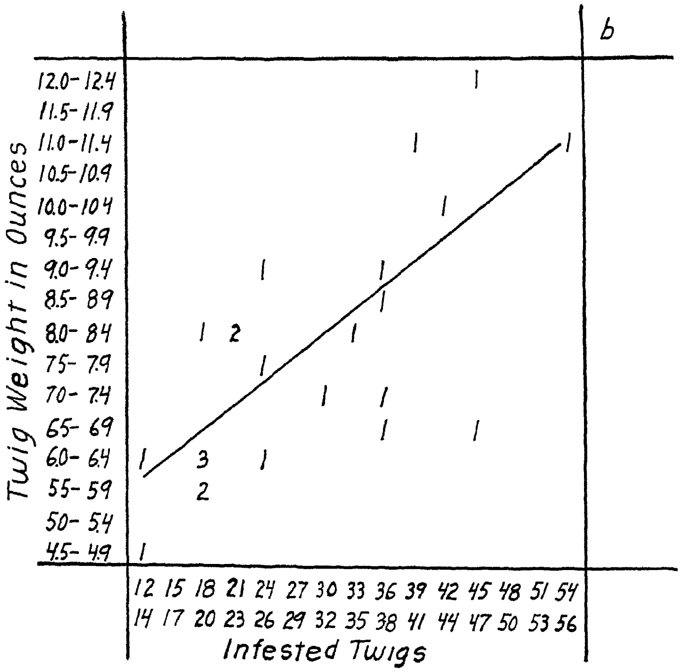

b
Twig Weight in Ounces
12.0-12.4
11.5-11.9
11.0-11.4
10.5-10.9
10.0-10.4
9.5-9.9
9.0-9.4
8.5-8.9
8.0-8.4
7.5-7.9
7.0-7.4
6.5-6.9
6.0-6.4
5.5-5.9
5.0-5.4
4.5-4.9
12 15 18 21 24 27 30 33 36 39 42 45 48 51 54
14 17 20 23 26 29 32 35 38 41 44 47 50 53 56
Infested Twigs

FIG.-10.

total number of injured twigs on each of the 24 trees in this plot was recorded in determining first brood twig injury. Measurements were made on July 22, but a few days after the twig injury counts had been recorded. The linear measurements of 50 twigs selected at random from all sides of the tree were secured; 25 were removed, and their weight was determined. The data obtained are summarized in Table 1.

TABLE 1. TOTAL NUMBER OF INJURED TWIGS, AVERAGE TWIG LENGTH AND TOTAL TWIG WEIGHT.

Number of Injured Twigs	Average Twig Length in Inches	Total Twig Weight in Ounces
54	7.0	11.0
46	4.1	6.5
45	9.6	12.0
43	7.2	10.0
41	6.2	11.0
38	6.2	8.5
37	6.9	9.0
37	6.2	6.5
37	5.1	7.0
33	5.2	8.0
31	4.4	7.0
26	6.4	9.0
26	4.9	7.5
26	4.0	6.0
23	5.7	8.0
21	4.2	8.0
20	3.4	8.5
19	3.4	5.5
19	3.4	6.0
18	4.8	8.0
18	3.3	6.0
18	3.2	6.0
13	3.3	6.0
12	3.1	4.5

It will be observed from an examination of Table 1 that the correlation between the total number of injured twigs per tree and the average length of such twigs is quite close. The correlation coefficient was found to be .7744 (Figure 1—a). The odds calculated from the formula $t = \frac{r}{\sqrt{1-r^2}} \times \sqrt{n'-2}$ as given by Fisher[1] are over 3,000,000 to 1 that the correlation is significant. The correlation coefficient between twig injury and twig weight as shown in Figure 1—b was found to be .7221 with the odds being 1,999,999 to 1 that the correlation is significant.

While making these measurements it was noted that a few of the trees which were apparently growing most rapidly were smaller than the average for the plot and consequently had a decreased number of growing twigs with a correspondingly reduced twig injury. Because of this

[1]R. A. Fisher—Statistical Methods for Research Workers, p. 159.

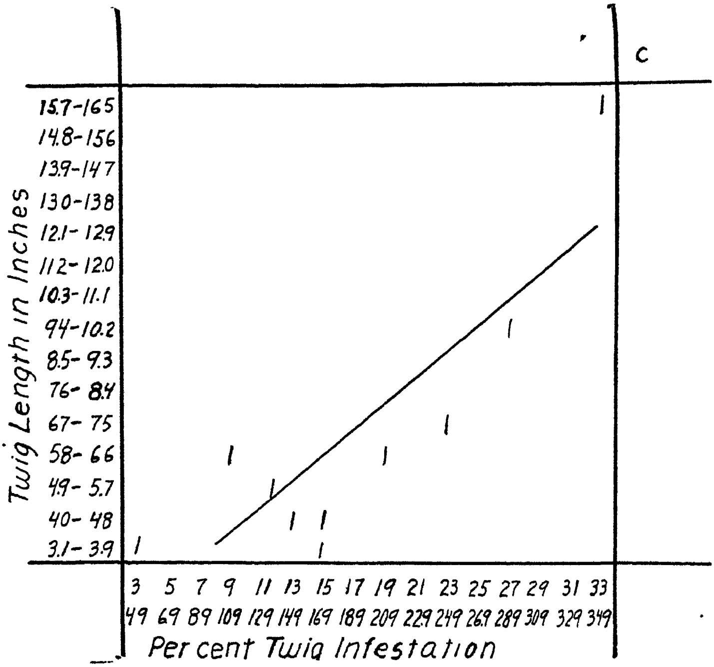

c
Twig Length in Inches
15.7-16.5
14.8-15.6
13.9-14.7
13.0-13.8
12.1-12.9
11.2-12.0
10.3-11.1
9.4-10.2
8.5-9.3
7.6-8.4
6.7-7.5
5.8-6.6
4.9-5.7
4.0-4.8
3.1-3.9
3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33
4.9 6.9 8.9 10.9 12.9 14.9 16.9 18.9 20.9 22.9 24.9 26.9 28.9 30.9 32.9 34.9
Per cent Twig Infestation

FIG.–11.

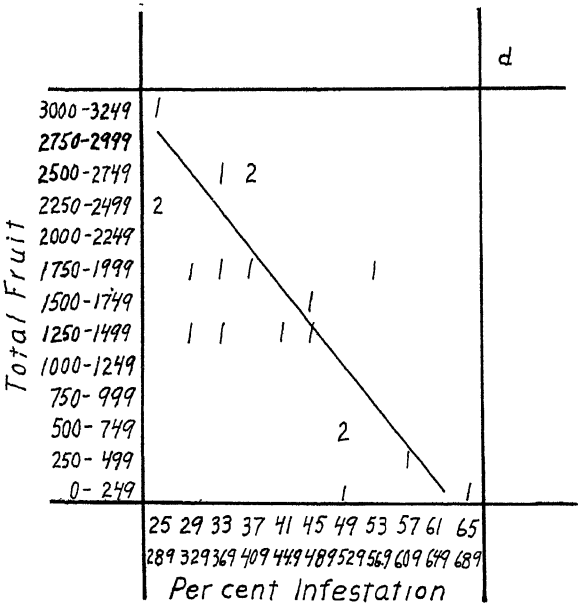

d
Total Fruit
3000-3249
2750-2999
2500-2749
2250-2499
2000-2249
1750-1999
1500-1749
1250-1499
1000-1249
750-999
500-749
250-499
0-249
25 29 33 37 41 45 49 53 57 61 65
28.9 32.9 36.9 40.9 44.9 48.9 52.9 56.9 60.9 64.9 68.9
Per cent Infestation

FIG.–12.

observation, ten trees varying greatly in size were selected and the percentage of injury for each tree obtained by recording the number of injured twigs in a total of 500 twigs chosen as follows: 100 on each of four sides and 100 in the top. These data are presented in Table 2.

TABLE 2. AVERAGE TWIG LENGTH AND PERCENTAGE OF INJURY

Percentage of Injury	Average Twig Length in Inches
33.5	15.7
28.0	9.6
23.3	7.0
19.2	6.2
16.6	4.1
15.0	3.2
13.4	4.2
11.4	4.9
10.0	6.4
3.0	3.1

In this case, the correlation coefficient between average twig length and the percentage twig injury was found to be .8475 with odds of over 1,428 to 1 that the correlation is significant. (Figure 11.)

An effort was also made to determine a possible relationship between the size of the crop and the degree of visible fruit injury. The pertinent data are summarized in Table 3. The total number of peaches in each of the 20 plots has been correlated with the *percentage* and the *number* of visibly injured fruit (Figure 9-13), correlation coefficients of—.7674 and .8981, respectively, being obtained with the odds in each instance over 10,000 to 1 that the correlation is significant.

TABLE 3.—TOTAL NUMBER OF PEACHES, NUMBER VISIBLY INJURED AND PERCENTAGE OF VISIBLE INJURY.

Total Number of Peaches	Number Visible Injured	Percentage Visible Injury
3090	887	28.7
2717	1050	38.6
*2572	832	32.35
2542	974	38.3
2475	634	25.6
2381	617	25.9
1874	641	34.2
1866	584	31.3
1785	714	40.0
1759	951	54.1
*1521	696	45.8
1456	689	47.3
1377	472	34.3
1375	412	30.0
1322	570	43.1
596	315	52.8
591	291	49.2
341	203	59.5
*242	128	52.9
188	128	68.1

*Identical treatments.

There is an apparent indication in the data presented that either more moths are attracted to the more rapidly growing trees and likewise to trees with greater quantities of fruit for oviposition or that more larvae survive and establish themselves in the twigs and fruit of such trees.

It seems probable that the larger the crop of fruit the less will be the percentage of injury but the greater the number of injured fruits.

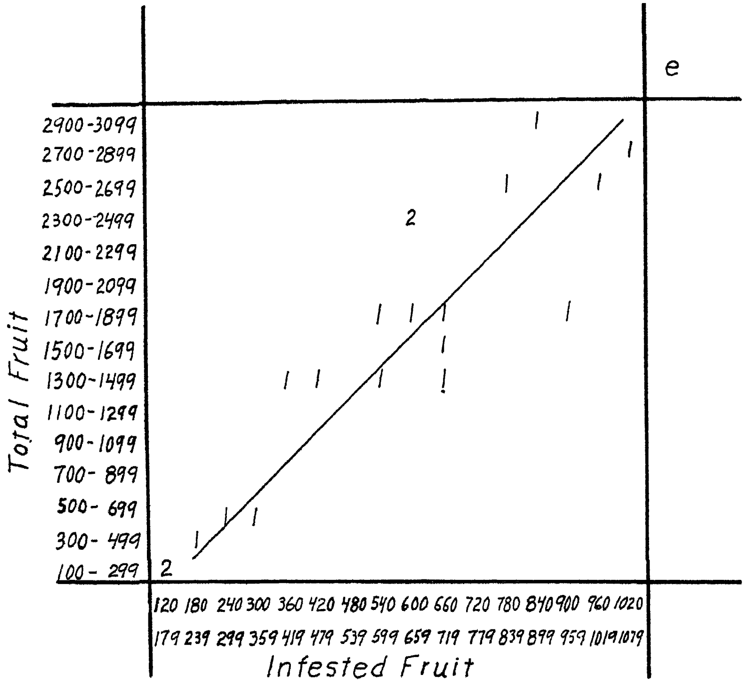


FIG.–13.

The infestation in a light crop of peaches cannot be compared, therefore, with the infestation in a full crop either on the basis of the percentage of visible injury or on the basis of the total number of injured fruits since both vary with the size of the crop.

In conclusion, it may be said that there is not only a positive but a decisive correlation between (a) tree vigor and twig infestation, (b) quantity of fruit and number of fruit injured, and (c) an inverse correlation between quantity of fruit and percentage of fruit injured.

PRESIDENT T. J. HEADLEE: The next paper is by L. A. Stearns and R. B. Neiswander.

HYDRATED LIME IN SUMMER SPRAYS FOR THE CONTROL OF THE ORIENTAL FRUIT MOTH

A SECOND REPORT

By L. A. STEARNS and R. B. NEISWANDER

ABSTRACT

The results of laboratory tests and of both cooperative and experimental orchard spraying conducted in Ohio during 1929 substantiate the preliminary data of 1928 and emphasize further the belief that a probable summer control of the Oriental Fruit Moth (*Laspeyresia molesta* Busck) may result thru a succession of early season sprays which will include hydrated lime or some like material acting as a physical or mechanical hindrance to oviposition, hatching and larval entry.

In a preliminary paper,[1] the authors discussed the results of laboratory tests and orchard spraying experiments conducted in Ohio during 1928 which indicated that heavy applications of hydrated lime either alone or in combination with insecticides offer promise as a control for the Oriental Fruit Moth. Such sprays act as a physical or mechanical hindrance to oviposition, hatching and larval entry.

Summer laboratory studies were continued and expanded in 1929, 21000 moths and 47000 eggs and larvae being employed in repellency, ovicidal and larvicidal tests conducted under both normal and controlled conditions of temperature and humidity.

The results in general substantiate those reported previously. A heavy hydrated lime spray (15–40 lbs. to 50 gals.) was effective as a repellent to oviposition (56–82 per cent), as an ovicide (10–28 per cent) and as a larvicide (15–87 per cent). Summer oils (2 per cent strength) showed corresponding efficiencies of 84, 99 and 76 per cent, respectively. The hydrated lime-summer oil combination, as compared with hydrated lime alone, proved much less effective as a repellent to oviposition (28 per cent), more highly effective as an ovicide (97 per cent) and about equally effective as a larvicide (71 per cent).

Eleven tons of hydrated lime and two tons of talc were employed in cooperative and experimental spraying and dusting during 1929. The hydrated lime, of high calcium content (CaO(Total), 73%; MgO (Total), .7%) and with 96 per cent passing thru 300 mesh, was the Bald Eagle Hydrate brand of the American Lime and Stone Company, Bellefonte, Pa. The 325 mesh talc was secured from the W. H. Loomis Talc Corporation, Gouverneur, N. Y.

[1]Stearns, L. A., and Neiswander, R. B. Hydrated Lime in Summer Sprays for the Control of the Oriental Fruit Moth—A Preliminary Report. Jour. Eco. Ent., 22:4, August, 1929, pp. 657–660.

Continued observations of the early seasonal development of this insect have shown that maximum emergence of the spring brood of

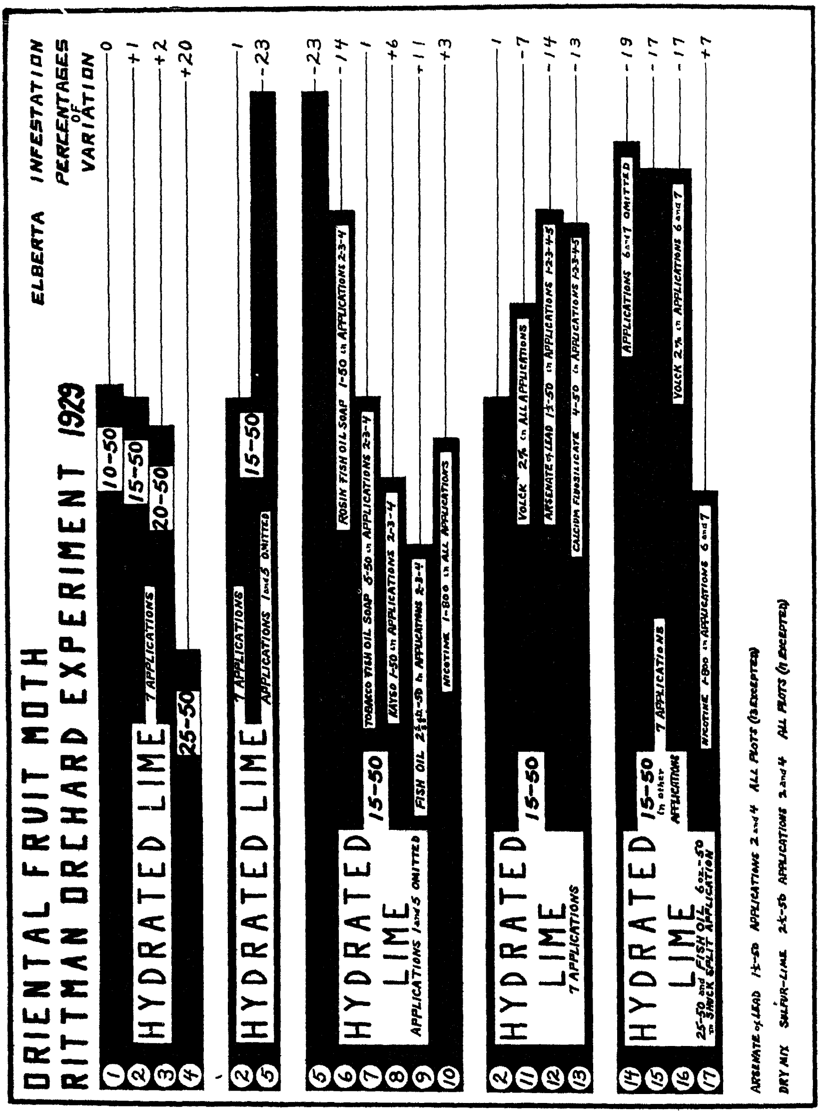


FIG.–14.

moths normally coincides with petal fall of the peach, its preferred host. This fact and the standard spray and dust treatments for peach in

Ohio were considered in formulating the tentative control schedule for 1929 presented in Table 1.

TABLE 1.—TENTATIVE SPRAYING AND DUSTING SCHEDULE, ORIENTAL FRUIT MOTH CONTROL, OHIO, 1929.

Brood	Application	Time	Materials: Spray Schedule (Seven Cooperators)	Dust Schedule (Two Cooperators)
	1	Bloom Off	Hydrated Lime 15–50	Talc
	2 (Standard* Treatment)	Shuck-Split	Hydrated Lime 25–50 Fish Oil 6 oz.–50 (Sulfur-Lime 12½–50) (Lead Arsenate 1½–50)	Talc (80–10–10)
1	3	1 Week Later	Hydrated Lime 15–50	Talc
	4 (Standard* Treatment)	2 Weeks Later	Hydrated Lime 15–50 (Sulfur-Lime 6½–50) (Lead Arsenate 1½–50)	Talc (80–10–10)
	5	3 Weeks Later	Hydrated Lime 15–50	Talc
	6	5½ Weeks Later	Hydrated Lime 15–50 Volck 1 gal.–50	Talc
2	7	6½ Weeks Later	Hydrated Lime 15–50 Volck 1 gal.–50	Talc

*Standard Treatment Materials in Parenthesis.
Preharvest spray or dust optional.

Eight representative peach growers in southern, central and northern Ohio, whose combined interests comprise some 200 acres of fruit, with varying severity of infestation, were secured as cooperators. By agrement, these cooperators recorded daily emergence of the spring brood of moths in standardized hibernation cages in their respective orchards, sprayed or dusted under supervision and in accordance with the schedule and with the materials furnished by the Ohio Station and summarized at the conclusion of the season their frequently recorded observations. Data relating to fruit infestation was secured by the authors at harvest.

Notwithstanding the exceptional and pronounced unfavorable weather conditions (excess precipitation range, 0.08 to 5.84 inches; average, 1.41 inches) (temperature deficiency range, 3.4 to 13.0 degrees; average, 5.8 degrees) prevailing during both the spraying and preharvest periods, from 25 to 56 per cent reduction in visible infestation was secured thru spraying. The complete records are summarized in Figure 15.

The 7-application talc dust schedule comparable with the 7-application hydrated lime spray schedule gave no better control than the usual two applications of dust, which in turn proved inferior to the similar two applications of spray.

In general, the infestation was less severe in the cooperative than in neighboring orchards and the larger the area treated the higher the degree of control. No difficulty was experienced due to the quantity

and character of the materials employed. No spray residue of an undesirable nature was encountered on the fruit at harvest. The growth of the limed trees exceeded that of the unlimed trees and the foliage

SUMMARY - COOPERATIVE SPRAYING AND DUSTING - ORIENTAL FRUIT MOTH CONTROL - OHIO - 1929

LOCALITY	VARIETY	TREATMENT		1929				1928			
				INFESTATION		CONTROL		INFESTATION		CONTROL	
		NUMBER OF APPLICATIONS	MATERIAL	VISIBLE	TOTAL	PERCENT REDUCTION IN INJURED FRUIT	PERCENT REDUCTION IN INFESTATION	VISIBLE	TOTAL	PERCENT REDUCTION IN INJURED FRUIT	PERCENT REDUCTION IN INFESTATION
ATHALIA	CARMAN	7	LIME	10	11						
	ALTON	..	..	6	10			0	2		
	ELBERTA	5	..	26	37.5	15-12.5	37-25				
	..	7	..	18	31	23-19	56-38	9	15	42-47	82-76
	..	2	NO LIME (S.O.S.)	41	50			51	62		
ROME	CARMAN	..	80-10-10 (S.O.D.)	38	39						
	ELBERTA	..	.. ..	59	67			19	28		
SOUTH POINT	..	3	LIME and additional dusts	18	32			49	62		
CINCINNATI-1	MAYFLOWER	5	LIME	0.5							
	CARMAN	..	..	9							
	ELBERTA	..	..	13	20			85	90		
	..	..	TALC DUST	+50							
CINCINNATI-2	..	7	LIME	15	29	8-5	35-15				
	..	2	NO LIME (S.O.S.)	23	34						
	..	7	TALC DUST	33	46	NO					
	..	2	80-10-10 (S.O.D.)	30	46						
CARROLL-1	..	7	LIME	7	11	3-8	30-42				
	..	2	NO LIME (S.O.S.)	10	19						
CARROLL-2	..	7	LIME	9	18	3-5	25-22				
	..	2	NO LIME (S.O.S.)	12	23						
COLUMBUS	SHIPPERS LATE RED	..	LIME	15	19			75	79		
BARNESVILLE	CARMAN	7	..	20		27-	57-				
	..	2	NO LIME (S.O.S.)	47							
	ELBERTA	7	LIME	56	70	7-8	11-10				
	..	2	NO LIME (S.O.S.)	63	78						
WALHONDING	..	7	LIME DUST	9	18	6-3	20-6				
	..	..	TALC ..	30	45	NO					
	..	2	80-10-10 (S.O.D.)	15	21						
STRONGSVILLE	..	5	LIME	33	67	17-12	34-15				
	..	2	NO LIME (S.O.S.)	50	79						
HENRIETTA	..	5	LIME	25	54	12-7	32-11.5				
	..	2	NO LIME (S.O.S.)	37	61						
DANBURY	..	7	LIME	24	35	19-16	44-31				
	..	2	NO LIME (S.O.S.)	43	51						
MAXIMUM						23-19	56-38				
MINIMUM						3-5	25-22				
AVERAGES	7 applications with Volck 2% in 6 and 7					16-12	46-27				
	.. ..					10-10	28-24				
	5 ..					15-11	34-17				

FIG. 15.—Summary, Experimental Spraying, Oriental Fruit Moth Control, Ohio, 1929.

appeared more healthy, larger and deeper green in color. Other insect and disease troubles were noticeably less. There was apparently better set of fruit on the limed trees and the increase in crop due to the larger size of the fruit was evident without actually measuring the yield. Post-harvest observations indicate increased fruit bud formation.

In experimental spraying, sixteen variations of the tentative control schedule furnished cooperators were followed out by the authors employing half-acre plots in an eight-year-old, cultivated Elberta orchard in a vigorous condition of growth. In planning the experiment, the uniformity of the experimental area was studied in respect to topography, direction of prevailing winds, planting irregularities, difference in growth conditions, variation in crop, et cetera, and the effect of these possible influencing factors guarded against by replication of certain treatments and by adequate checks. Records of both twig and fruit infestation for each tree were secured.

Untreated areas showed a visible infestation of 42 per cent, an additional infestation of supposedly clean fruit amounting to 26 per cent and a total infestation of 58 per cent.

Although still maintained, the sequence in reduced twig injury for plots treated with increasing amounts of hydrated lime was less pronounced in decreased fruit infestation at harvest. In Figure 14, the percentages of variation for the several treatments are expressed graphically in relation to the least effective of the hydrated lime (alone) series to which has been assigned the arbitrary value of zero.

The results indicate a possible greater effectiveness with either a 7-application schedule of hydrated lime increased thruout from 15 to 25 pounds to 50 gallons of water or a 5-application schedule (at increased rate) (applications 1 and 5 omitted) with an adequate spreader and sticker included in applications 2, 3 and 4.

PRESIDENT T. J. HEADLEE: Next is a paper by W. P. Yetter.

STUDIES OF BAIT TRAPS FOR THE ORIENTAL FRUIT MOTH IN SOUTHERN INDIANA IN 1929

By W. P. YETTER, JR., *Associate Entomologist, Deciduous Fruit Insect Investigations, U. S. Bureau of Entomology, Vincennes, Ind.*

ABSTRACT

The work in southern Indiana with baits for the oriental fruit moth (*Laspeyresia molesta* Busck) has thus far been of a preliminary nature but the results point to certain possibilities. Various aromatic chemicals when used in solutions of blackstrap molasses or granulated sugar gave good catches. Boiled peach juice shows promise. The use of a screen of ¼-inch mesh over the mouth of the bait promises to make these traps more efficient.

Preliminary work this past summer (1929) in southern Indiana[1] with oriental fruit moth baits has given some very interesting and encouraging results, in fact good enough to warrant giving this phase of control further consideration.

Starting June 27, which was well along in the season, with 62 wide-mouth quart jars of the Kerr type (Plate 1, B) and later increasing the number to 74, the writer was able to trap, by September 30, 16,906 oriental fruit moths. The traps were hung on poles and placed near the center of the peach trees, as shown in Plate 2. The baits in which the stock solutions were of sugar or of molasses were placed in trees of the

TABLE 1.—ORIENTAL FRUIT MOTHS CAUGHT IN THE MOLASSES-SOLUTION SERIES OF BAITS DURING THE SUMMER OF 1929. VINCENNES, INDIANA

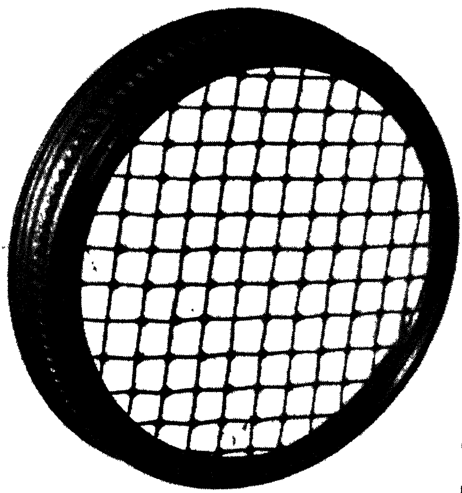
Description of Solution Each trap contained 1 quart of 10 per cent molasses plus 90 per cent water, by volume, with 1 cubic centimeter of one of the following:	Duration of Test	Kind of Trap	Total Moths Caught	Average per Trap per Day
Citral	June 27–Sept. 30	1 jar	708	7.45
Benzyl cinnamate	do	do	519	5.46
Diethyl phthalate	do	do	418	4.42
Methyl cinnamate	do	do	364	3.83
Bromo styrol[1]	do	4 jars	1379	3.63
Citronellal	July 17–Sept. 30	1 pan	318	3.35
Geraniol[1]	June 27–Sept. 30	4 jars	1128	2.97
Benzyl benzoate	do	1 jar	251	2.64
Ethyl propionate, Tech	July 17–Sept. 30	1 pan	238	2.51
10 per cent molasses solution alone[1]	June 27–Sept. 30	2 jars	477	2.50
Diphenyl oxide	do	1 jar	189	1.99
Benzyl phenyl acetate	do	do	170	1.79
Safrol	do	do	155	1.63
Methyl salicylate	do	do	132	1.39
Iso butyl acetate C. P	do	do	111	1.17
Benzyl propionate	do	do	103	1.08
Terpineol	do	do	96	1.01
Ethyl oeanthate	do	do	89	.93
Amyl oeanthate	do	do	73	.77
Ethyl benzoate C. P	do	do	66	.69
Iso butyl phenyl acetate	do	do	52	.55
Amyl salicylate	do	do	25	.26

[1]Unfortunately the data for this bait were not recorded as from the individual traps but from them collectively.

Hiley and Carman varieties. The Carman peaches were harvested the last of July and the Hileys, August 7. The traps containing peach juice were placed in a near-by block of Hales on August 23 after the crop had been harvested.

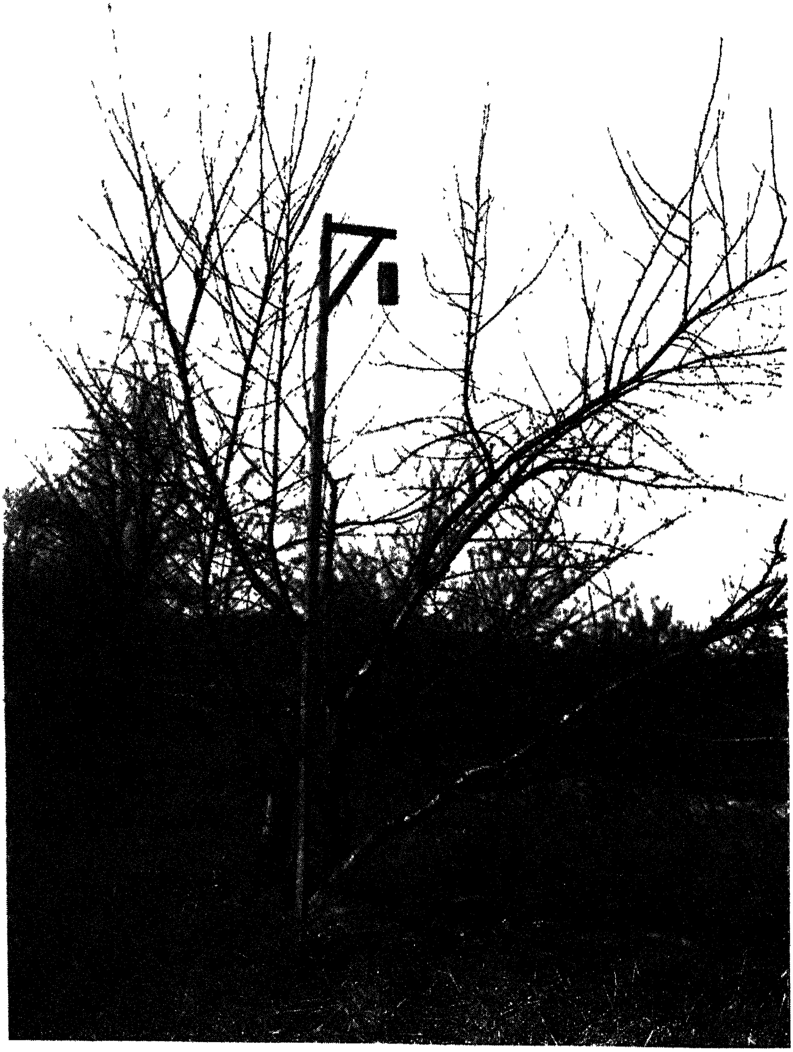
[1]The investigations on which this paper are based were conducted at the field laboratory maintained at Vincennes, Indiana, by the U. S. Bureau of Entomology, under the general supervision of Dr. A. L. Quaintance and in cooperation with the Purdue University Agricultural Experiment Station.

Plate 1



A—Screen cover for bait trap for capturing oriental fruit moth.

B—Glass bait trap with bale and screen cover.



Oriental fruit moth trap suspended from 10-foot pole near center of tree.

Glass containers of the Kerr type are preferred by the writer to the enameled stew-pans or painted metal ones; first, because evaporation is slower; second, because no chemical reaction between the materials used and the container takes place; third, because they offer more resistance to the wind, which means less loss of liquid through swaying; and fourth, because they are less awkward to handle.

One trap was used to a tree and, unless otherwise indicated, each material was used in one trap only.

A stock solution consisting of 1 part of blackstrap molasses and 9 parts of water, by volume, was used in one series of baits, as will be seen in Table 1. One cubic centimeter of the chemical used was added to each quart of stock solution. The chemicals showing the most promise in this stock solution are, in order of the numbers of moths caught, as follows: citral, benzyl cinnamate, diethyl phthalate, methyl cinnamate, bromo styrol, and citronellal. The stock solution alone did very well.

TABLE 2.—ORIENTAL FRUIT MOTHS CAUGHT IN THE SUGAR-SOLUTION SERIES OF BAITS DURING THE SUMMER OF 1929. VINCENNES, INDIANA.

Description of Solution Each trap contained 1 quart of water plus 3 ounces of granulated sugar with 1 cubic centimeter of one of the following:	Duration of Test	Kind of Trap	Total Moths Caught	Average per Trap per Day
Methyl cinnamate	June 27–Sept. 30	1 jar	575	6.06
Bromo styrol[1]	do	4 jars	1937	5.10
Sugar solution alone[1]	do	2 jars	705	3.70
Benzyl cinnamate	do	1 jar	300	3.16
Ethyl oeanthate	do	do	292	3.07
Iso butyl phenyl acetate	do	do	270	2.84
Diphenyl oxide	do	do	267	2.81
Iso butyl acetate C. P.	do	do	261	2.75
Safrol	do	do	259	2.72
Citral	do	do	242	2.55
Geraniol[1]	do	4 jars	912	2.40
Diethyl phthalate	do	1 jar	228	2.40
Amyl oeanthate	do	do	217	2.28
Ethyl benzoate C. P.	do	do	214	2.25
Benzyl propionate	do	do	201	2.12
Benzyl phenyl acetate	do	do	200	2.10
Methyl salicylate	do	do	182	1.92
Terpineol	do	do	180	1.89
Ethyl propionate, Tech	July 17–Sept. 30	1 pan	163	1.72
Citronellal	do	do	127	1.34
Amyl salicylate	June 27–Sept. 30	1 jar	108	1.14
Benzyl benzoate	do	do	70	.74

[1]Unfortunately the data for this bait were not recorded as from the individual traps but from them collectively.

In another series (Table 2) a stock solution consisting of 3 ounces of granulated sugar in each quart of water was used. One cubic centimeter

of the chemical used was added to each quart of stock solution. The chemicals showing the most promise in this solution are, in order of the numbers of moths caught, as follows: methyl cinnamate, bromo styrol, benzyl cinnamate, ethyl oeanthate, iso butyl phenyl acetate, and diphenyl oxide. The two jars containing sugar solution alone captured sufficient moths, however, to place this solution in efficiency between bromo styrol and benzyl cinnamate in the foregoing list of chemicals.

A number of tests have shown that a screen of ¼-inch mesh placed over the mouth of the trap is largely responsible for an increased catch of oriental fruit moths. This screen is coarse enough to admit the moths but fine enough to exclude large insects which would otherwise fill the trap. These wide-mouth glass jars are obtainable with 2-piece tin lids consisting of a screw top and a disk. When the jars are to be used for trapping the disk is replaced by a circular section of the screen (Plate 1, A) which is held over the mouth of the trap by screwing down the top.

TABLE 3.—ORIENTAL FRUIT MOTHS CAUGHT IN BAITED TRAPS TESTED WITH AND WITHOUT SCREEN OVER THE MOUTH, FROM JULY 23 TO SEPTEMBER 30, 1929, VINCENNES, INDIANA

Description of Solution 1 quart of water plus 3 ounces of granulated sugar with one cubic centimeter of one of the following:	Duration of Test	Kind of Trap	Total Moths Caught	Average per Trap per Day
Bromo styrol, in trap with wire screen over mouth	July 23–Sept. 30	1 jar	407	5.89
Bromo styrol, in trap without wire screen over mouth	do	do	184	2.66
Methyl cinnamate, in trap with wire screen over mouth	do	do	307	4.44
Methyl cinnamate, in trap without wire screen over mouth	do	do	277	4.01

In the tests reported in Table 3 the screens increased greatly the catch of oriental fruit moths in the case of bromo styrol and increased it slightly with methyl cinnamate.

Peach juice made from 20 pounds of fresh peaches boiled for one hour in 5 gallons of water gave excellent results (see Table 4) where used at the rate of 1 part, by volume, of the juice to 3 parts of water, with 3 ounces of granulated sugar added to each quart of solution and with a wire screen of ¼-inch mesh placed over the mouth of the trap. Where either the sugar or the screen was omitted, the catch was poor.

The peach traps with screens caught three times as many oriental fruit moths as those with no screens. The traps with screens and sugar caught more than four and one-half times as many moths as those with sugar but no screens.

TABLE 4.—ORIENTAL FRUIT MOTHS CAUGHT IN BOILED-PEACH-JUICE BAITS TESTED WITH AND WITHOUT SCREENS AND SUGAR FROM AUGUST 23 TO SEPTEMBER 30, 1929, VINCENNES, INDIANA

Description of solution	Duration of Test	Kind of Trap	Total Moths Caught	Average per Trap per Day
B. P. J., 1–3,[1] in trap with wire screen over mouth..........	Aug. 23–Sept. 30	3 jars	46	0.40
B. P. J., 1–3, in trap without wire screen over mouth.............	do	do	15	0.13
B. P. J., 1–3, plus 3 ounces of sugar, in trap with wire screen over mouth...	do	do	575	5.04
B. P. J., 1–3, plus 3 ounces of sugar in trap without wire screen over mouth	do	do	124	1.08

[1]B. P. J., 1–3 = Boiled peach juice 1 part to 3 parts water by volume. This peach juice was made by boiling 20 pounds of fresh peaches in 5 gallons of water for one hour. The liquid was then drained off and placed in a wooden barrel. The peach pulp was squeezed in a tight sack and the thick fluid acquired was then added to the liquid first obtained.

It is firmly believed that the bait trap still has possibilities in the control of the oriental fruit moth and is worth following up, especially since there is no effective insecticide control measure. There is a strong possibility of finding a bait more attractive than ordinary molasses or sugar solution, as indicated by the large numbers of moths caught with certain combinations of aromatic and sugar or molasses solutions, as well as with boiled peach juice and sugar solution. As traps the glass containers have advantages over the enamel stew-pans or painted metal ones, and the use of a screen over the mouth of the traps promises to make them more efficient.

MR. J. J. DAVIS: May I ask permission to make a few remarks regarding the Oriental fruit worm, but not bearing on the last paper?

At the request of Dr. Allen, we did submit a title for the program but too late to be included, but at his suggestion I should like to make a few remarks regarding the artificial introduction of one of the Oriental fruit worm parasites in Indiana.

Through the courtesy of Dr. Allen and other members of the Riverton, N. J. laboratory, we collected several thousand infested peach twigs the latter part of May this past year. From that collection, we reared something over 500 specimens of *Macrocentrus ancylivora*, the parasite which has proven very efficient in the control of the Oriental fruit worm in New Jersey. According to our records, we had never reared it in Indiana, and had reason to believe that it was not present, at least not in the area where the parasites were liberated.

The 500 parasites were liberated in an orchard near Vincennes, the latter part of June, and weekly collections and records were made by Mr. L. F. Steiner. A summary of the results are somewhat as follows:

At a distance of 500 feet northeast of the released area, we obtained, by the end of the season, a maximum of 10.8 per cent parasitism; 150 feet northeast of the released area, 55.9 per cent parasitism; 400 feet southwest of the released area, 58.1 per cent parasitism; 1000 feet southwest of the released area, 43.3 per cent parasitism.

In this connection, I might say that the prevailing winds were from the southwest so that the spread seemed to be against the wind.

I mention these facts simply to show the possibility of artificial introduction of this particular parasite and possibly others, and we hope we may be able to continue this work another season.

I might add that Dr. Allen sent us parasites later in the season, late in August, and these parasites were released near Mitchell, Indiana, but they were released too late to secure any result on the degree of twig parasitism.

President T. J. Headlee: The experience of Professor Davis with *Macrocentrus ancylivora* is also duplicated in infested areas where the parasite is already present. Even under such conditions, an artificial introduction during the current year has given a material increase in parasitism.

Mr. L. Haseman: We are interested in the western movement of this moth and in the control measures used by growers in Illinois and Indiana. Is it possible to make any prediction as to how serious it is likely to become in an apple growing section where peach growing is of no consequence? I would like to know what the observations of the men to the East show regarding this.

Mr. W. P. Flint: For the past three years in the southern part of Illinois, we find where apple and peach orchards adjoin we get a very serious infestation of the apple from this fruit moth. We get some infestation in apple twigs. Where apple orchards are removed as much as a quarter of a mile we haven't had any trouble so far.

President T. J. Headlee: Our experience with this particular problem indicates that where peach and apple trees are interplanted, or stand adjacent, there is a transposition of the Oriental fruit moth, or peach moth, to the apple, but that transposition with us is late in the season. The early fruit does not seem to be troubled in New Jersey; the late fruit is, infestation occurring as late as October, the young worms being sometimes carried into storage. It is perfectly controllable, however, on apple by such methods as were shown here with the oil pyrethrum or the nicotine tannate.

MR. P. J. PARROTT: I should like to ask a question in regard to these bait traps. Have any of the men working with bait traps any idea of the approximate number of moths you have to entrap in order to derive benefit as shown by the degree of freedom of the fruit from injury or the rate of infestation?

MR. W. P. YETTER: We hope to find a solution to that question by large scale work. So far, we can't answer it.

PRESIDENT T. J. HEADLEE: We will now hear a paper by Leonard Haseman.

OBSERVATIONS ON A NEW APPLE MINING CATERPILLAR IN MISSOURI

By LEONARD HASEMAN, *Columbia, Mo.*

ABSTRACT

This small maggot-like caterpillar of the genus *Carposina* has been doing some damage to apples in Central Missouri during the past two years. Observations on its distribution, life cycle and habits, and its presence in great abundance in the native red haws (Crataegus) are included.

In the fall of 1928 fruit growers in the commercial apple growing section around Waverly, Missouri sent to the department of entomology samples of apples, which showed a new type of injury. A trip toWaverly was made at once to secure breeding material and information on the distribution of the pest and the conditions in and around the infested orchards. The writer was struck by the close resemblance of the small white caterpillar to the one he had repeatedly taken in red haws around Columbia late in the fall. Samples of the worm were preserved and sent to the Bureau of Entomology for determination and Mr. Heinrich identified it as a species of Carposina. The caterpillars collected late in the fall of 1928 became fulfed but failed to transform to the moth stage, so its specific identity is still unknown. The amount of damage done to the 1928 crop was small and no reports of the work of the worm were received from any other part of the State.

During the summer of 1929, through the cooperation and financial assistance of the fruit growers of the Waverly district and the Missouri Pacific Railroad, a temporary laboratory was established at Waverly, partly to assist with the control of the serious outbreak of codling moth and partly for the purpose of studying this new apple worm. The work was closed out the first of August and up to that time no signs of the new worm were observed. By the latter part of August, however, its work was again in evidence. Additional breeding material was collected at Waverly and at Columbia and a considerable number of the fulfed

worms have spun their small spherical cocoons and it is hoped that moths will emerge from these next year.

DISTRIBUTION. During the fall reports received from fruit growers and county agents and observations by the writer have shown that the worm is not confined to the Waverly area in Central Missouri. It was common at Columbia and in the Kansas City and St. Joseph areas. The writer found no evidence of it this fall in Southwest Missouri where limited observations were made. Members of the Bureau of Entomology reported its occurrence at several points in West Central and Northwest Missouri and in Northeastern Kansas. Inspectors of the Missouri State Board of Agriculture have also done considerable scouting work and found it at several points in the western and northwestern part of the State. A fruit dealer in Kansas City claimed to have received a badly infested shipment of fruit from Colorado. It seems evident from these records that the worm is quite widely distributed in apple growing areas in Missouri and in Kansas.

FRUITS ATTACKED. Some growers claim that it is partial to Jonathans and Grimes Golden, while others report it especially on the Ingram. It feeds also in Gano and in the laboratory seems to develop normally in various varieties of apples, also in the fruit of a foreign crablike pome. As mentioned previously, the caterpillar resembles one found abundant late in the fall in the native red haws. Mr. Heinrich recently identified this haw caterpillar also as a species of Carposina. Immature worms from haws collected the middle of November when transferred to apple continued to feed and caused the characteristic minelike injury. The fulfed worms have also spun identical spherical cocoons in the breeding jars. That the two caterpillars are identical and that the pest is going over from the native haws to the apple seems certain, but it will be necessary to rear the moths for specific determination before we can be sure.

NATURE AND EXTENT OF INJURY. The injury to apple caused by this caterpillar begins as a dark spot which later extends as a slender dark streak around under the peeling. It may run halfway around the apple, or it may be only an inch long. The small worm enters the fruit at the head of the serpentine mine or tunnel. After traveling about for a time it usually begins to eat out a conspicuous blotch mine immediately under the peel. The peel dries out, turns brown, and in time may become wrinkled and cracked. As the worm approaches maturity it often goes deep in the pulp working about the core. It may leave the fruit when fulfed through the mine, or it may cut a new tunnel to

the surface, often at the calyx end. The worm in red haw mines out all the pulp, leaving only the dry peel and the seeds. In the breeding jars a worm may feed in two or more haws before it is fulfed. In the haw it throws out a conspicuous pile of spherical brown pellets of excrement. In the case of apple, this expulsion of the excrement is not so evident, much of it being left in the tunnel.

The injury eventually causes the fruit to rot. Unfortunately, most of the damage is done after the winter apples are picked and stored, the grower not being able to detect the very early work while culling the fruit. Jonathans picked, wrapped and stored in a fruit cellar about the middle of September showed no signs of the worm, though two months later several apples showed the typical injury. Within half a mile of this home orchard the writer collected two gallons of badly infested haws.

Growth and Development of the Larva. The earliest evidence of this pest this year showed up in late August and half-grown worms were taken in haws as late as November 15. Fulfed worms emerged from stored apples as late as the first week in December. In the breeding jars kept in the warm laboratory the last worms emerged the first of December from the haws collected November 15. The past fall in Central Missouri was abnormally late, the first real severe frost not occurring until early in November. Under these conditions the pest, no doubt, was able to breed later than usual, but this year egg laying must have continued well into October. The very young worms under laboratory conditions become fulfed in from four to six weeks.

Thus far the pupa, moth and egg stages have not been observed and it is not possible to say whether or not there is more than one generation of the insect a year. It would seem, however, from observations begun in the fall of 1928 that the insect is single brooded and that oviposition may continue from sometime in August until well into October.

Larva. The larva is a white maggot-like caterpillar with very short prolegs. Its slow movements resemble those of a maggot and, when in motion, it is shaped like a maggot with its hind segments much larger. When at rest, or in case of dead specimens, this is less noticeable. It is quite transparent and the reddish-brown food content of the stomach is very prominent in live specimens. A seta-map of *Carposina fernaldana* is given by Dr. W. T. M. Forbes in his "Lepidoptera of New York and Neighboring States," fig. 293, page 514, and he states that the Carposinidae have a mixture of characters of the Tineids, Tortricids, and Pyralids.

COCOON. When fulfed, the worm is about a centimeter long. After leaving the fruit it crawls about in the breeding jar for a time, spinning much silk as it crawls. It then burrows just beneath the surface of the sand or soil where it prepares a tough spherical cocoon of brown silk. The cocoon has sand grains or soil attached to its surface. It is about five millimeters in diameter and the worm inside is found to be curled so that the head and hind segments meet. From present information, it would seem that the transformation to the moth stage does not occur until the following fall. Considering the lateness of the maturity of the worms in the fall, the winter must be passed in the larval stage.

CONTROL. It is impossible at this time to predict how important the pest may become in the future. If it continues to attack apples and increases in abundance, it is sure to become a very serious pest. With its late fall oviposition after all spraying work is done, control by spraying seems out of the question. If it is merely a native haw worm which is developing an appetite for apple, in time it may let up, but in case it does not the destruction of all haws in the vicinity of apple orchards should put an end to its destructive work. Those worms which develop in apples are largely removed from the orchard and disposed of with the fruit, so that without wild haws in which to carry over naturally the pest can be cleared up. The hawthorn blossom is Missouri's official state flower and the writer realizes that it will require some tact in putting across a haw-cutting campaign, but it may prove necessary in the commercial apple growing regions.

PRESIDENT T. J. HEADLEE: Next is a paper by A. A. Granovsky.

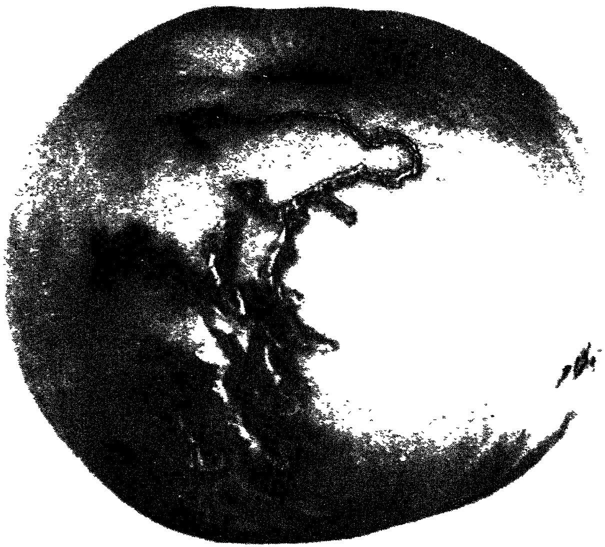
A NEW INSECT PEST OF CHERRIES IN WISCONSIN

By A. A. GRANOVSKY, *Madison, Wisc.*

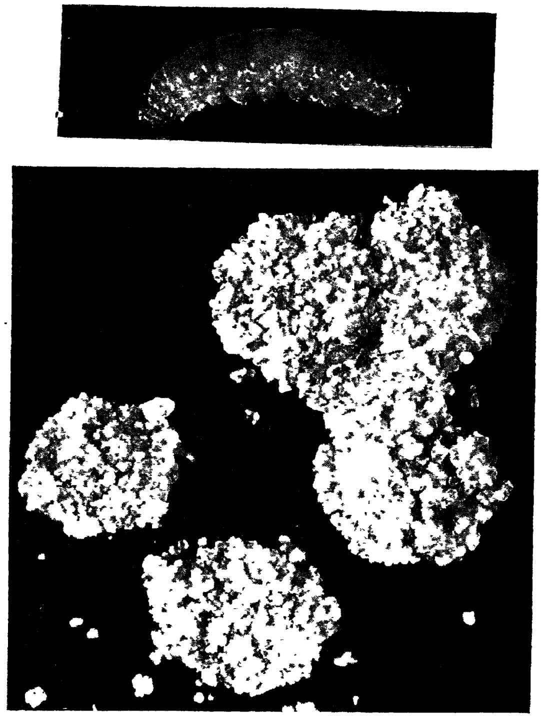
(Withdrawn for publication elsewhere)

MR. P. J. PARROTT: In listening to Mr. Granovsky's paper I was very much impressed with the resistance of the casebearer to applications of arsenicals during the period when the insects were attacking the buds. This past summer an opportunity was afforded me of noting the destructive capacity of the apple casebearer in West Virginia as well as to observe the effect of different sprays on the insect. As in the instance of the species attacking cherries, Professor Peairs could make little headway against th pest by applications of arsenicals during spring and early summer. However, midsummer applications of an oil in combination with nicotine sulfate against the eggs, I believe, or the newly-hatched caterpillars afforded a high degree of protection. Working as they have on very similar problems, these men would

Plate 3



Apple showing typical injury by Carposina caterpillar.



Winter cocoon of Carposina caterpillar, full grown. larvae above.

do well to compare the results of their experiments since apparently some phases of their studies are leading to similar conclusions.

In this connection, Mr. Harman of our department who is studying the bud moth finds that midsummer applications of nicotine or arsenate of lead are effective against the young larvae of the summer brood; and while the overwintering caterpillars are quite resistant to arsenicals applied during the spring they are, nevertheless, vulnerable to an application of nicotine sulfate.

PRESIDENT T. J. HEADLEE: The next paper is by Dwight Isely.

FIDIA LONGIPES AS A GRAPE PEST[1]

By DWIGHT ISELY, *University of Arkansas*

ABSTRACT

The grape root worm (*Fidia viticida* Walsh) is replaced in importance in the grape belt of Arkansas by *F. longipes* Melsh.[2] A summary of the habits and life history of the latter species is given.

The grape root worm (*Fidia viticida*) is usually considered the most important insect attacking grapes in the northern grape belts, and is the most generally distributed insect pest in those regions. While Arkansas is generally included in its range, I know of no specimens of this insect having been collected in the grape belt of the northwest part of this state. Until recently it appeared that this pest not only did not occur, but that it has no counterpart in this region.

The closely related species *Fidia longipes* Melsh. appeared in 1928 to fill the place of the root worm in Arkansas, and was of still greater general importance in 1929. *F. longipes* has long been known to feed upon grape foliage. Hitherto it has not been noted as a pest, as far as I know, nor is there any information regarding its immature stages.

It was first described by Melsheimer[3] from Pennsylvania, in 1847, and later in 1855 redescribed by Uhler as *F. viticola*. Its distribution is given by Johnson and Hammar[4] as the Mississippi Valley and Eastern States. According to Blatchley,[5] its distribution in Indiana is confined to the southern part of the state, indicating that it is a more southern species than *F. viticida*. Because of the overshadowing importance of *F. viticida* it is possible that *F. longipes* has been confused with it in some of the literature of economic entomology, and hence the distribution of

[1]Research Paper No. 162. Journal Series, University of Arkansas.

[2]Order Coleoptera; family Chrysomelidae.

[3]Melsheimer, F. E. Descriptions of New Species of Coleoptera of the United States. Proc. Acad. Nat. Sci. Phila., 3:158–181. *Eumolpus longipes*, p. 169. 1847.

[4]Johnson, Fred, and Hammar, A. G. The Grape Root Worm. U. S. D. A. Bur. Ent. Bul. 89. 100 p. *F. longipes*, p. 16. 1910.

[5]Blatchley, W. S. Coleoptera . . . of Indiana. 1385 p. *F. longipes*, p. 1143. 1910.

this species cannot be clearly defined. If it is distinctly a more southern species, we might apply as a common name, the southern grape root worm.

Fidia longipes is fairly common, from a collector's point of view, throughout Arkansas. I have taken a few beetles of this species nearly every year since 1918, the first year of my residence within the state. However, I did not know of its occurring in abundance before 1928. It was generally taken on the foliage of wild grape, and was not widely distributed. The change in the status of this species from being merely of interest from a collector's point of view to that of a pest may be due to the development of the grape industry in the Ozarks during the past few years. According to the U. S. Census of 1920,[6] in the five northwestern counties of Arkansas there were 540 acres of grapes. Most of this acreage was scattered and there was only one small group of commercial vineyards. Five years later this acreage had increased to 6,541, according to the Census of Agriculture for 1925.[7] There has been some increase in acreage since that time. The result is that the numbers of its host have not only been greatly increased, but that grapes are grown under a greater variety of conditions.

F. longipes was found in approximately 15 per cent of the vineyards visited in July, 1929. In some of these vineyards the beetles were abundant enough to cause serious foliage injury. All of the infested vineyards were on well drained hill land. No specimens were found in vineyards in valleys nor in those on flat poorly drained soil.

No attempt can be made at this time to estimate the economic importance of this insect. While its conspicuous abundance during the past two seasons is probably due in part to the great increase in grape acreage, some climatic factors may also be involved. However, even if it does not develop as a regular annual pest, it must be regarded as at least an occasional one.

In habits and life history, as in general appearance of all its stages, *Fidia longipes* resembles *F. viticida*. For the sake of comparison, a brief summary of its habits and life history will be given.

The adults feed upon the upper surface of grape foliage, leaving conspicuous chain-like feeding marks. The larvae feed upon the roots but are not proportionately as abundant as *F. viticida* around the crown of the plant nor around the larger roots. There is a single generation a year. The first adults emerged from the soil in 1929 on June 13, which

[6]Fourteenth Census of the United States, for 1920. State Compendium for Arkansas, p. 83–89. 1924.

[7]U. S. Census for Agriculture for 1925, p. 944–953, 1927.

was about one month after blossoming of grapes. In relation to the development of its host, this is a somewhat later date of emergence than that of the grape root worm in the north. During both years the beetles were abundant throughout the latter part of June until mid-July, when they began to decline in numbers. Beetles were rare after the first of August.

The shortest preoviposition period was 19 days. The elongate, cylindrical, yellowish white eggs are deposited in patches of 20 to 60 under bark scales. The eggs hatch in six or seven days (in July) and the larvae drop to the soil and feed among the roots. The larvae form a hibernation cell below the frost line, where they remain until May. They feed for a short time in the spring, form their pupal cells, and transform to the adult stage.

PRESIDENT T. J. HEADLEE: The next paper is by C. L. Metcalf and A. S. Colby.

THE MEADOW GRASSHOPPER, *ORCHELIMUM VULGARE* HARRIS, A NEW RASPBERRY PEST[1]

By C. L. METCALF and A. S. COLBY, *University of Illinois*

ABSTRACT

Orchelimum vulgare Harris, not hitherto reported as destructive to raspberry, did much damage by ovipositing in canes of Illinois plantations adjoining crops of clover, cowpeas and alfalfa in 1928 and 1929. Egg-laying scars, oviposition, hatching, and molting are described. Cultural and mechanical control measures are suggested. An egg parasite is recorded.

The vast majority of destructive insects cause injury by feeding. A relatively small number injure plants in laying their eggs. When several raspberry growers of southern Illinois brought to our attention quantities of canes damaged in the manner shown by Pl. 4, fig. 1, we were at a loss to ascribe the trouble to any known raspberry pest. Nor did inquiry among our entomological friends or a survey of the literature on raspberry insects give us any help.

One of our correspondents reported that he and his son had collected by hand, gallons of a large green grasshopper from the infested canes and fed them to chickens. He secured for us some specimens of what he believed to be the same pest. Among the insects secured was a single specimen of *Orchelimum vulgare* Harris. This gave us a clew to Hancock's (1904) paper, which describes the egg-laying of *Orchelimum glaberrimum* in bush marigold and to the discussion by Forbes (1905) of *Orchelimum* as a minor pest of corn. Subsequent work in the Fall of

[1]Contribution from the department of horticulture and from the entomological laboratories of the University of Illinois, No. 144.

1929 proved that *Orchelimum vulgare* (Pl. 4, fig. 2) was responsible for the injury under consideration.

Forbes (1900, 1905) records the eggs from sugar beets, corn stalks, especially just below the tassel, elder twigs, the stems of dog-bane, lamb's quarters, Spanish needle, horse-nettle, crab-grass, raspberry, blackberry, timothy, *Boltonia*, *Baptisia*, and *Cuina arundinacea*. Riley (1893) records injury to sorghum tips in Arkansas. Leonard (1926) records the female laying eggs in pigweed and in an old fence rail.

We have a few specimens of injury to raspberry collected by a student at Urbana, in October, 1927; but apparently the insect has not hitherto been recorded as a raspberry pest.

IMPORTANCE.—The 1928 injury was severe in several raspberry plantations in southern Illinois. Both the red and black species were attacked. No varietal differences were noted, the Cumberland (black) and the Latham (red) being affected equally. In many cases the egg punctures were found well distributed throughout the length of the young canes of the season. As high as 70 per cent of these canes were injured and where they were left through the winter the majority were so weakened and splintered with eggs that they broke off at one of the egg-laying scars and fell to the ground.

The 1929 injury was not so severe, as stringent control measures were taken in 1928, when the outbreak was first noted. The insect was reported in other and widely separated plantations in southern Illinois this season, however.

DISTRIBUTION.—According to Blatchley (1920) the insect ranges from southern Maine and southern Quebec, north and west through Ontario to northern Minnesota, Colorado, and eastern Wyoming and south and southwest to North Carolina, Georgia, Missouri, Arkansas and northeast Texas. Injury has been noted in Illinois during 1928 and 1929 in Dongola, Villa Ridge, Mount Vernon, Johnston City and Jerseyville.

PLATE 4

1.—Characteristic injury to raspberry cane. The average distance, center to center, of the scars is slightly over ½ inch. 2.—Mature female of *O. vulgare* in characteristic resting position on raspberry cane. Length of female from top of head to apex of ovipositor is about $1\frac{3}{16}$ inch (30 mm.). 3.—Female in the act of laying her eggs, the ovipositor not yet fully sunken into the cane. 4.—Raspberry cane split open to show eggs in position in pith. Some of the eggs dropped out when the cane was split. A single egg of a tree cricket at x shows the comparative size. 5.—Three eggs much enlarged, to show the variation in size that results chiefly from compression against the pith and adjoining eggs. The eggs average ¼ inch in length. 6.—Egg shell from which nymph has hatched. Note pebbling of the chorion as shown at one end of shell.

Plate 4

6

Oviposition.—Egg-laying takes place during late September and early October in southern Illinois. It had practically ceased by October 15 in 1929.

In laying eggs, the female (Pl. 4, fig. 3) takes a position lengthwise of the twig or cane, with her four fore legs embracing the cane to give good purchase in the act which follows.

The middle region of the body is now arched or humped in a semicircle, bringing the apex of the abdomen far forward beneath the body until the tip of the ovipositor scrapes the bark of the twig beneath the thorax. Standing on tip-toe, the female then makes a few tentative thrusts with this sword-like organ. The tip having been anchored in the bark, the female begins to pull with her legs and push with her ovipositor, while swaying the body slightly from side to side, thus bringing great pressure to bear against the twig with the ovipositor, which sinks slowly into the bark, becoming buried to its base in a few seconds. Although entering the twig nearly at a right angle, the ovipositor as it sinks into the pith is directed backward, so that the apical part of it comes to lie nearly parallel with the long axis of the cane. As Hancock remarks, the curved, blade-like organ is beautifully adapted to its use. The egg is then forced into place between the guides of the ovipositor and the ovipositor is withdrawn, leaving the egg with its head end near the puncture and the rest of it extending away from the puncture in a direction opposite to that in which the female was facing.

In the cases timed, about six minutes elapsed while the ovipositor was sunken in the twig. When the ovipositor is withdrawn the female turns right or left, swinging the body around to face in the opposite direction, with the head over the puncture just made. The mandibles grasp the twig and by cutting and pulling, like a dog gnawing a bone, tear the twig into the splintered condition characteristic of this species. The superficial scarring of the twigs is therefore done with the mouth parts. In the cases observed from 25 seconds to 1 minute were occupied in the splintering process following each egg deposition. Then, moving forward slightly, the body is again arched, the ovipositor feels for the egg puncture and, if successful in finding it, is sunken through the same aperture but directed this time in the opposite direction. After this egg is laid and the ovipositor removed, the insect again turns to face in the opposite direction, splinters the twig above the puncture some more and then, advancing slightly, thrusts the ovipositor a third time thru the original aperture and places a third egg by the side of the first one laid. This process of laying eggs, directed alternately up and down the twig, and each deposition followed by splintering the wood

above the puncture, continues sometimes until ten or twelve eggs are laid about a single puncture, four or five lying abreast at each side of the puncture, their head ends facing the head ends of those at the other side of the puncture and all facing the opening in the lacerated twig (Pl. 4, fig. 4). In cases of such heavy deposition the interior of the twig becomes packed with eggs in contact with each other or separated by thin lamellae of compressed pith.

When the scars are made close together the posterior ends of eggs from adjoining scars may overlap and they are frequently pressed out of the normal shape, which is circular in cross-section, by the crowding that results. It is believed that the toughness and pliability of the egg shell prevents the ovipositor from breaking eggs, already laid, by its subsequent thrusts. The ovipositor may also be sensitive to the presence of eggs in the pith and avoid thrusting directly into them. The diameter of the raspberry canes attacked ranged from 5/64 to 12/64 inch, the average being about 1/8 inch in diameter. These canes are commonly splintered by a row of from 8 to several dozen scars, extending from 6 inches to as much as 5 feet along the cane.

The distance from center to center of adjacent egg-scars on several twigs measured ranged from 1/4 inch to 7/8 inch. The average distance was a little more than 1/2 inch, center to center. The length of the splintered portion, or scar itself, ranges from 3/8 to 5/8 inch and averages about 1/4 inch. The scars are oval in shape and about twice as long as wide. In any one scar there are usually about 12 to 20 strands of the lacerated cortex of the cane. Most of them although pulled up at mid-length are not broken; but a few free ends of the splinters usually project at the middle of the scar.

The number of eggs beneath a single scar varies greatly. In general more eggs were laid per puncture in 1928 than in 1929, possibly because of the greater abundance of insects on the plants. The records of a few counts are as follows. The eggs lying adjacent to the same puncture are indicated by connecting hyphens, the first figure of each pair being that toward the apex of the twig from the puncture. Each line represents a series from one twig.

1928

3–4, 6–2, 2–2, 3-2, 3–2, 1–1, 0–3.
0–0, 2–1, 1–1, 3–2, 1–2, 1–3, 0–1.
9–3, 2–2, 3–2, 4–3, 3–3, 2–3, 5–4, 2–4, 4–5.

1929

1–1, 1–2, 1–0, 1–0, 1–3, 1–3, 0–1, 1–1, 1–1, 0–1, 2–1, 1–1, 1–0, 1–1, 1–2.
0–0, 0–0, 0–0, 1–1, 1–1, 1–1, 1–2, 2–2, 2–1, 1–2, 1–0, 1–1.

The maximum number found beneath a single scar was twelve, nine to one side and three to the other. Many were found with four and five side by side beneath each half of the scar. Hancock (1904) found a single pair of eggs laid at each scar by *Orchelimum glaberrimum* and Forbes records one or two above (distad of) the opening and the same number below, two to four in all. Poorly splintered scars and scars in very small canes are especially likely to be devoid of eggs. In the twig last recorded above, the first three scars which had no eggs beneath them were in a very slender part of the cane, only 5/64 inch in diameter. That part of the cane bearing the scars with 1–1 each was about 6/64 inch in diameter, while that bearing 1–2 and 2–2 was about 8/64 inch.

When a single egg lies to each side of the puncture in a small cane, it is usually nearly straight and parallel to the axis of the twig. When a number of eggs are laid in a larger cane they are generally tilted or curved somewhat diagonally across the cane, with their head ends pointing toward the puncture in the bark. Such eggs are variously curved or bent and compressed in conformity to their position in the stem and to the other eggs about them. The egg (Pl.4, fig. 5) measures from 6 to 6.5 mm. or about ¼ inch in length. The maximum dorso-ventral diameter is about 1.25 to 1.35 mm. (1/20 inch). Hancock (1904) gave the diameter as .7 mm. and Forbes (1905) as .75 mm. thick. Our measurements, made both from eggs which had overwintered and from recently-laid ones, were rarely less than 1 mm. thick. The egg shell is finely and evenly pebbled (Pl. 4, fig. 6) somewhat like the grain of artificial leather, the pebbbling being of such size that 20 to 25 of the grains occur to the linear millimeter. The end of the egg at which the head of the embryo lies and which is always directed toward the middle of the scar made by the female, is much more pointed than the opposite end.

If the egg shells are moistened with water a short time before hatching, the embryo can be seen more clearly through the chorion. The most conspicuous objects are the compound eyes which lie about a millimeter and a half from the apex of the anterior end or a little less than one-fourth the way back. The frons lies in the very apex of the egg shell. Along the ventral side one can detect something of the developing mouth parts. All legs lie with the knee-joint directed caudad. The hind tibiae lie closely parallel along the ventral side of the egg throughout the posterior half of its length. The femora are parallel to the tibiae and the knee joint of the third pair of legs falls about 1 mm. short of reaching the posterior end of the egg. The dark-colored, very slender antennae extend from the head region along the venter between the tibiae, projecting half a millimeter beyond the knee joint where they

pass over dorsad and then sharply forward along each side of the egg shell to well cephalad of the middle of the body. In the middle region they are bowed dorsad to skirt or escape some portion of the legs, probably the coxae. In front of this point they appear to bend ventrad and terminate close to the mouth parts.

HATCHING.—The hatching of the nymphs of *Orchelimum* from over-wintering eggs, in twigs allowed to remain until early spring under normal conditions out-of-doors, and subsequently kept at room temperature in the laboratory, occurred from April 20 to May 10. The nymphs hatch almost exclusively at night. Darkness and high humidity seem to be stimuli to hatching. In the jars kept in the laboratory, very few nymphs emerged during the day but swarms of them were hopping about in the morning that had emerged during the night. In order to observe the process of hatching it was necessary to watch the cages all night. The artificial light required to make observations was also apparently a deterrent. From a group of canes that yielded 90 nymphs on April 27th, only twenty hatched under observation the following night and all of them after midnight. The following night, April 29, the same lot of twigs yielded 86 nymphs; April 30, 65; and May 1st, 20.

The following experiment may have some significance: The available canes were divided, on the night of April 29th, into four lots by arbitrarily counting the twigs into four groups. Two of the four lots were thoroly wetted and placed over moist cotton at 8:30 p. m. The other two were kept dry. One of the wet and one of the dry lots were placed under artificial illumination all night long from the rays of three, fifty-watt, Mazda bulbs with reflectors. The other two lots were kept in the darkness of an unlighted, shaded room. On the night of April 30th the lots illuminated the preceding night were placed in darkness and the other two illuminated. On the night of May 1 the lots were again reversed. At nine o'clock in the morning the results were as follows:

	April 29		April 30		May 1	
	Light	Dark	Light	Dark	Light	Dark
Wet	19	37	8	55	6	12
Dry	0	30	2	0	0	2

Number of nymphs emerged from wetted twigs	137
Number of nymphs emerged from dry twigs	34
Number of nymphs emerged in darkness	136
Number of nymphs emerged in artificial light	35

This and other observations lead us to conclude that wetting and darkness are favorable to emergence of nymphs from eggs that are ready to hatch.

The first observable act in the hatching of Orchelimum is the sudden shooting out from the splintered egg scar of the green, first stage nymph, enclosed in its pellicle or exuvia until it stands nearly full length away from the wood and egg shell and usually at an angle of about 75 or 80 degrees from the twig. The egg shell remains *in situ* in the pith, its anterior end having been split wide open. The nymph gains its freedom from the egg shell by convulsive, twisting movements, playing the body backward and forward and from side to side, but without using the legs to grasp any object whatever. It slips out of the egg shell and becomes erected to nearly the full length of the nymph in a very few seconds. So quickly does this process take place that one must be extremely alert to succeed in observing its initiation at all. At this time the nymph is anchored to the twig and egg shell only by the tip of the abdomen and by its very long antennae which have yet to be freed, as subsequently described. At this stage the body is uniform green, quite straight, and without any swelling whatever in the region of the thorax.

Hatching, from the earliest appearance of the nymph on the surface of the scar until the exuvia of the first nymph breaks, occupied, in the cases timed, 2 to 3 minutes. Eggs in which the embryos were almost completely developed, that were removed from the pith in apparently perfect condition and kept under the most favorable conditions did not hatch in a single case. Consequently the beginning of the eclosion could not be observed and the time elapsing between the rupture of the egg shell and the expulsion of the nymph from the egg is unknown.

First Molt.—When the nymph is exposed nearly full length, and erect at the side of the twig, peristaltic movements begin from the abdomen toward the thorax. This obviously carries the body contents, whether it be blood or air, into the region of the thorax and at once the thoracic dorsum begins to throb. The top of the head and the thoracic nota become greatly swollen.

Soon the pellicle bursts by a median longitudinal rift over the thoracic nota and these parts, greatly swollen, protrude. Within 15 to 30 seconds after the break in the exuvia, the latter has been slipped over the forehead and down on the under side of the head to the mouth parts, smoothly and easily and with surprising rapidity. This stage of the process is suggestive of a tight sweater being removed over one's head or a finger being punched thru the end of a rubber glove. The body is now shifted sideways and up and down, the mouth parts and bases of the antennae soon becoming exposed. Within à minute after the rupture of the exuvia, the entire thorax, the bases of the antennae and the coxae of all

the legs are exposed. The abdominal segments are now worked in and out of the enveloping exuvia like a stinger or plunger, crowding or pulling it backward from the anterior portion of the body much as a youngster kicks a blanket down by the activity of his legs. Within 1½ minutes after the rupture of the exuviae, the femora of all the legs are exposed to the tibiae. The free portion of the body continues its bending from side to side while the abdomen pumps back and forth in its exuvial pellicle. The legs during this time are all extended straight along the venter of the body closely parallel to each other. A half minute more suffices to free the tibiae of all the legs and an additional half-minute releases the tarsi of fore and middle legs, the fore tarsi becoming free at the same time the hind legs are exposed to the knee. Within 2 to 3 minutes of the bursting of the exuvia, the long hind femora have escaped from their pellicles and all the body except the tip of the abdomen, the hind tibiae and the antennae are now free.

About the time that the bases of the hind femora are well exposed, the nymph begins the remarkable process of freeing its extraordinarily long antennae from their cases which extend far out behind the nymph as it drags itself from the egg shell. The basal segments of the antennae are large and prominent and they project ventrad and then caudad rather close and taut behind the head. The nymph now wraps its short, 3-segmented labial palps about the portion of the antennae which are at this time directly opposite the mouth parts.

By bending the back sharply upward and elevating the head as much as possible while the palps lock about the antennae, the latter are pulled a short distance out of their cases. Then the back is humped or bent ventrally, a new grasp is taken of the antennae at a point a little further distad, and again locking the palps about the antennae, they are tugged out a little further. The abdomen contracts as the head is bent down to grasp the antennae and as the antennae are pulled out the abdomen extends, adding its force to the task. This performance is repeated about 60 to 70 times, each pull resulting in drawing the antennae somewhat further free from their ensheathing exuviae. As they are pulled further and further forward, they bow out in front of the head to form two prominent ellipses. The insect works rapidly, giving a new tug at the antennae at intervals of about two seconds. The action of the palps in grasping the antennae suggests the way in which a log chain is used in logging operations by passing it loosely around a tree trunk; as it is pulled forward it locks sufficiently tight to draw the log away. The two antennae lie parallel, close together, separated by about their own diameter and the labial palps overlap slightly, the apex of

one in front of the other like folded arms. In this way the antennae are held tight to the ligula and the grasp is a very secure one. The pellicle is slipped over the hind knee-joint at the same time that the palps first lock about the antennae. The tibiae now become bent sharply and seem to give additional purchase for the long pull at the antennae. The two processes continue simultaneously, the antennae being pulled out and the tibiae slipping out of their cases at the same time. Within 4 to 4½ minutes of the bursting of the exuvia the very last segments of the antennae have passed thru the embrace of the labium.

This appears to be the signal for the use of the legs and for the first time they are brought into action. They reach down, grasp the twig very quickly, pull the tip of the abdomen and the hind tibiae free from their pellicles, and the insect immediately walks away. Five minutes is the time required for the molting of the first exuvia from the time the break in the exuvia begins until the insect walks away. The pellicle or exuvia of the first nymph remains partially enclosed by the egg shell. That portion which covered the tip of the abdomen and a very large part of the antennal cases are enclosed by the shell while the covering of head, thorax and a portion of the abdomen are left projecting from the egg upon the surface of the cane, like a bright, crumpled green rag (later becoming white). It is thus possible to tell approximately how many nymphs have hatched from any egg scar by these exuviae. The newly molted second instar nymphs are remarkably active, walking and jumping about and performing other activities in a very efficient manner, the moment they are freed from the exuvia, in striking contrast to the sedentary first instar nymph.

The newly emerged, second-instar nymph is entirely pale green in color except for the compound eyes which are gray blue or lavender. There is no trace of the median, brown, longitudinal stripe, which however, begins to appear within half an hour as reddish-brown, granular material margining the faintly pulsating heart or dorsal blood vessel. The newly-hatched nymph measures between 4½ and 5 mm. in length from the forehead to the apex of the abdomen, while the antennae measure about 18 mm. The hind femur and hind tibia each measures 3.5 mm. The width of the head is 1.25 mm.

The duration of the second instar is about 9 to 10 days. There is some difficulty in determining duration of the different stadia since the exuviae, following the first, are devoured, and it is difficult to recognize the different instars. In one case observed the molted skin was not eaten for an hour and a half but was subsequently devoured. The number of nymphal instars has not been determined. The nymphs are

very active, hiding and skipping about among dense growths of clover and other vegetation and seeming to prefer upland meadows and fence rows.

Ordinarily the young nymphs exhibit a rather definite, positive phototropism. However, when they have been injured or are sickly they appear not to respond to the attraction of light, and in a number of cases to be negatively phototropic. Associated with the positive phototropism is a negative geotropism, and with the negative phototropism a positive geotropism. It is obvious that the reversal of these tropisms in the case of injured or sickly individuals might be of very real value to them. While the positive phototropism and negative geotropism lead them upward and toward the light where their food is most likely to be in a satisfactory condition, the negative phototropism and positive geotropism of the sickly ones would lead them to seek shelter in dark, untraversed places where they would be most likely to escape certain natural enemies.

The positive reaction to light and tendency to climb upward are strong enough to make these reactions a very real help in transferring specimens from one container to another. When the opportunity is presented to crawl upward toward the light into a fresh jar, 70 to 90% of the individuals usually respond very promptly. There are commonly 10 to 20% that remain in the old jar. Sometimes these react to shaking and jarring and sometimes they refuse to pass into the new jar, regardless of efforts. The latter individuals almost invariably prove to be ones which have the antennae partly injured and which jump with reluctance, or not at all, and usually die within a few days.

There can be no doubt that the antennae of a second instar nymph are organs of very great significance to this insect. In one specimen the right and left antennae happened to become somewhat entangled as the insect was molting. It showed the greatest evidence of distress and restlessness and discomfort, racing from end to end of the tube, flailing the antennae about in every direction and finally bowing them backward and pulling them through the mouth parts until they were finally separated from each other. Within an hour or two of hatching, the mid-dorsal line becomes greatly darkened for about one-third the total transverse width of the body in dorsal aspect.

Cannibalism.—Cannibalism occurs to some extent among the young nymphs of *Orchelimum*, at least in captivity. The nymphs appear to attack each other primarily on the long antennae. A very great number of them are found with one or both antennae partially chewed off. We have noticed that when one antenna is largely missing the nymph

is irresponsive to light-stimulus while in most of the cases of sickly individuals the antennae are missing. Whether the shock of losing the antennae is responsible for their weakened condition or whether, having become weakened, they are more readily attacked by the other nymphs, we are unable to say. The nymphs suddenly pounce upon their victim and begin to devour it at any point which comes in contact with the mouth parts. The body fluids are imbibed and the entire skeleton devoured. They can jump about with their victim held in the front legs and are not easily frightened away from the feast. One second-instar nymph fed upon another of the same instar for half an hour. They seem to devour only those individuals that have been weakened especially by the loss of the antennae. Hancock records cannibalism among the adults.

FOOD.—The nymphs feed readily on the foliage of red clover. In captivity they also ate bean-foliage and the blossom buds of barberry. Clover was favored among a large variety of foods tried. Smith (1908) records that the adults feed on cranberry seeds. Blatchley reports the adults as feeding on the bodies of small moths and on a soldier beetle. Forbes (1905) found from stomach examinations that eight specimens of *vulgare* had eaten mainly insects, mostly aphids, with some pistils and leaf tissues of grasses and pollen and fungus spores.

LIFE-CYCLE.—There is normally one generation a year. Winter is passed in the egg stage in the pith of plants. In the case of raspberry the canes usually break off and fall to the ground. Nymphs hatch from the overwintering eggs in May and June. The nymphs are common in July and August. Adults begin to appear in late July. Eggs are laid in September and October.

CONTROL MEASURES.—The raspberry plant is a biennial, the canes growing one season and fruiting the following summer, after which they dry up and die. Since the eggs of the grasshopper are laid in the young canes, this wood must of necessity be cut out and burned as a control measure as soon as possible after oviposition and certainly before the eggs hatch. During 1928, in some patches, eggs were found deposited from within a few inches of the ground out to the tips of the canes. Infested wood was cut out and burned. This wholesale destruction of fruiting wood was costly, since a very light crop of berries was secured in 1929.

Hand-picking was resorted to in one plantation. Early in the morning when the grasshoppers were not very active, it was found possible to catch them in large numbers. Where one or both of these control

measures was systematically followed out, the infestation was materially reduced by 1929. In 1929, however, the insect was found at work for the first time in other, newly-set plantations in counties adjoining the 1928 outbreak. While the insect is able to live on a wide variety of host plants, it evidently prefers to lay its eggs on the raspberry when this plant is convenient. Therefore, it will be wise to be on the watch for the pest in order to combat it effectively as it appears in isolated patches in widely separated localities.

Most of the outbreaks of 1928 and 1929 were in plantations partially surrounded by leguminous plants, such as clover, cowpeas, or alfalfa. In one case there was an asparagus bed at one side. Clover and similar forage crops are favorite food plants of the nymphs. When the crops are cut and removed from the field the grasshoppers move over to the raspberry plantation close by. This close juxtaposition of leguminous plants and raspberry should be avoided. The planting of peas as a cover crop in raspberry plantations is probably unwise in sections where this pest is prevalent. Weeds should not be allowed to grow during the summer. Clean cultivation, followed by a low growing cover-crop, such as oats, planted in September, is to be recommended.

Numerous specimens of a Proctotrupoid parasite of the family Scelionidae emerged from the egg-bearing canes in the laboratory. These have been determined by Mr. A. B. Gahan as *Tumidiscapus flavus* Girault, a species previously reared from puparia of the Hessian fly. Dr. L. O. Howard comments that this is an example of the condition where the oviposition impulse arises from the gross resemblance and method of life of the hosts, rather than from any taxonomic relationship.

Literature Cited

HANCOCK, J. L. 1904. Oviposition and Carnivorous Habits of the Green Meadow Grasshopper (*Orchelimum glaberrimum* Burmeister). Psyche, 11:69–71.

FORBES, S. A. 1900. Economic Entomology of the Sugar Beet. Illinois Agric. Exp. Sta. Bull. 60, 483.

FORBES, S. A. 1905. A Monograph of Insect Injuries to Indian Corn. 23rd Report State Entomologist Illinois, 144–146.

RILEY, C. V. 1893. Notes from Correspondents. Insect Life, 5:204.

BLATCHLEY, W. S. 1920. Orthoptera of Northeastern America. Nature Publishing Company, Indianapolis, 542–545.

MORSE, ALBERT P. 1919. Manual of the Orthoptera of New England. Proc. Boston Soc. Nat. Hist., 359–360.

SMITH, J. B. 1908. Cranberry Insects. 29th Annual Report, New Jersey Agr Exp. Station, 341.

LEONARD, M. D. 1926. A List of the Insects of New York. Cornell University. Memoir 101, 23.

MR. L. HASEMAN: I might say we have that insect in Missouri.

MR. J. J. DAVIS: I might add that about two years ago Dr. Porter handed us specimens of this insect which caused considerable injury to roses growing in greenhouses at Vincennes, Indiana, by ovipositing in the twigs.

PRESIDENT T. J. HEADLEE: Next is a paper by E. P. Felt.

THE ECONOMIC IMPORTANCE OF SHADE TREE INSECTS

By Dr. E. P. FELT, *Director and Chief Entomologist, Bartlett Tree Research Laboratories, Stamford, Conn.*

ABSTRACT

It is not so easy, in the case of shade trees, to establish the relation between a generally unsatisfactory condition and insect infestation as in the case of fruit trees. There is no difficulty in seeing the connection between a dying tree and the work of cambium borers, such as the two-lined chestnut borer, the bronze birch borer, the spotted hemlock borer and the sugar maple borer. The scale insects constitute a relatively inconspicuous group capable of causing serious injury. The oyster shell scale and the elm bark louse, in particular, are occasionally very abundant and injurious, the former frequently killing good sized ash and poplar trees. The tulip tree scale is another pernicious insect. The aphids or plant lice are occasionally extremely abundant and while the immediate results may not be as striking as in the case of severe infestations by scale insects, there is undoubtedly a lowering of vitality, through interference with the functioning of the leaf. A small series of gall insects produce appreciable injury. This is especially true of a number of the knotty oak galls. In the case of shade trees, symmetry and sightliness are important factors, consequently insects which affect the normal development of the tree by preventing growth or killing branches are undesirable.

The leaf eating insects, such as canker worms and the elm leaf beetle frequently devour a considerable proportion of the foliage, and this can but have a material effect upon the vigor and the growth of the tree. The periodical outbreaks of the Pandora moth in western pine forests have resulted in the reduction in the width of the annual rings by 80%. It is more than probable that severe infestations by scale insects and plant lice materially affect the thickness of the annual rings. There are other causes which may produce this, namely deficient rainfall and thin soil or a gradual depletion in soil fertility. It is not easy to differentiate between the various causes.

The mere reduction in the amount of wood produced in any one season is not the most serious phase of the problem. Weakening of branches or leaves is usually evident first in the upper limbs and is followed by greater susceptibility to both insect attack and fungous infection. It is believed that a combination of these agencies, each of variable importance under different conditions, explains in considerable measure the many dying tips generally assoicated with what we consider a "stagheaded" condition. We need more data as to the part insects play in producing such conditions. How much of this can be traced back to earlier attacks by insects? Shade trees have a material value and it is our contention that this should be taken into account in estimating the economic importance of shade tree insects. We believe it much more economical to protect a tree from insect depredations than it is to replace such a tree with one of equal size.

Many fruit growers have learned the importance of protecting trees from insect depredations if they are to secure satisfactory crops. It is comparatively easy to connect injured fruit with insect depredations and to demonstrate that a weakened growth and smaller numbers of fruit buds may be traced back to injuries resulting from the work of borers, scale insects or leaf feeders. It is not so easy, in the case of shade trees, to establish the relation between a generally unsatisfactory condition and insect infestation and yet this frequently exists. The purpose of this paper is to present certain criteria for judging the effects of insect attack upon shade trees.

There is no difficulty in seeing the connection between a dying tree and the work of such cambium borers as the two-lined chestnut borer, *Agrilus bilineatus* Web., the bronze birch borer, *Agrilus anxius* Gory, the spotted hemlock borer, *Melanophila fulvoguttata* Harr., and the sugar maple borer, *Glycobius speciosus* Say, to mention just a few. It is evident that these insects when sufficiently abundant girdle the tree or the part affected and cause a relatively speedy death, excepting possibly in the case of the sugar maple borer. Infestation by this maple insect usually persists through a long series of years, an occasional limb being killed or a serious scar produced upon the trunk. There is rarely a sufficient infestation to cause speedy death of entire trees, though this does occur. The scattered, pernicious work of this borer over a series of years causes great damage and may ultimately ruin even good sized trees. The work of this pest is much more general in the northeastern United States, at least, than most realize.

The scale insects constitute a relatively inconspicuous group capable of causing serious injury. The oyster shell scale, *Lepidosaphes ulmi* Linn., and the elm bark louse, *Gossyparia spuria* Mod., in particular, are occasionally very abundant and injurious, the former occurring more frequently upon American elms and the latter thriving best on European elms. The oyster shell scale frequently kills good sized ash and poplars. The tulip tree scale, *Toumeyella liriodendri* Gmel., is another of these pests occasionally abundant enough to kill even good sized branches. The presence of this insect is somewhat readily detected, since its large size makes it conspicuous and in mid-summer there is a copious exudation of honeydew comparable to that produced by the elm bark louse. The abundance of any of these or other scale insects means an enormous draft upon the vitality of the tree, usually resulting in weakening of branches, sometimes good sized limbs, and may end in considerable killing of terminals.

The aphids or plant lice are occasionally extremely abundant upon various trees and while the immediate results may not be as striking as in the case of severe infestations by scale insects, there is undoubtedly a lowering of vitality through interference with the functioning of the leaf both by withdrawal of sap and the partial smothering due to an abundance of honeydew. The Norway maple aphid, *Chaitophorus lyropicta* Kess., is a common and almost chronic offender in the northeastern United States and in recent years, at least, there has developed a type of injury or annoyance previously hardly noticed, namely the smearing and disfiguring with honeydew of automobiles standing under trees in mid-summer. This was very prevalent in southwestern Connecticut the past summer and something difficult to avoid if the car was upon the street much of the time.

A small series, at least, of gall insects may produce appreciable injury. This is especially true of the knotty oak galls, *Andricus punctatus* Bass., *A. cornigerus* O. S., *A. clavigerus*, Ashm., several species of which become extremely abundant and not only disfigure good sized trees but kill limbs and even parts of trees. Several records have come to us of certain species killing trees. In addition to the conspicuous galls, we need also to take into account the various species which infest buds, particularly of oaks, and prevent their development. Several cases have come to notice where this injury assumed appreciable proportions, and this may account for poor twig development in certain cases. We have a similar type of injury by a plant mite, *Eriophyes avellanae* Nal., in the case of the European filbert, as much as 25% of the buds may be blasted and there are reasons for thinking that twigs are weakened and die as a consequence.

In the case of shade trees, symmetry and sightliness are important factors quite aside from the vigor of the tree, consequently insects which affect the normal development of the tree by preventing growth or killing branches are undesirable and the same is true of a number of species which produce large numbers of galls and unsightly foliage. The hackberry bud gall of *Pachypsylla gemma* Riley causes an undesirable deformation on the smaller twigs, which is entirely avoidable in the case of feature trees, at least. The abundant nipple leaf galls on hackberry produced by *Pachypsylla mamma* Riley come in the second category. This is also true of the bladder gall of the soft maple produced by a species of plant mite, *Phyllocoptes quadripes* Shim.

The leaf eating insects, such as canker worms, *Paleacrita vernata* Peck and *Alsophila pometaria* Harr., and the elm leaf beetle, *Galerucella xanthomelaena* Schrank, to mention just a few, frequently devour a con-

siderable proportion of the foliage and this cannot but have a material effect upon the vigor and growth of the tree.

Minott and Guild[1] in a careful study of the effects of gipsy moth defoliation upon oaks in New England found that growth declines in practically a constant ratio. An average defoliation of 34% existed and the actual decline in growth was found to be 38%, this resulting in the premature death of a considerable part of the affected trees.

There has appeared recently a bulletin upon the Pandora Moth, *Coloradia pandora* Blake, a periodic pest of western pine forests, and the author, Mr. J. E. Patterson, has satisfied himself that the width of the annual rings may be reduced as much as 80% from the normal in years when this insect is abundant. He finds that injury of this character may extend over a series of years and is quite likely to bring about conditions favorable for invasion by various pine bark beetles. It is more than probable that severe infestations by scale insects and plant lice as well as defoliations by leaf feeders may result in a great reduction in the thickness of the annual rings. We believe it important to recognize this phase of insect injury and the eventual outcome of such conditions. The immediate injury is not necessarily the more serious.

There are other causes which may produce very thin annular tree rings, such as deficient rainfall, particularly in the case of trees in swamps where variations in the height of the water table are especially serious. Deficient growth may be due to changes in drainage, the latter not infrequent in newly developed areas. A thin soil or a gradual depletion in soil fertility, due to the systematic removal of vegetable matter, as for example, on closely clipped lawns and an insufficient replenishment, likewise limit wood development. It is not easy to differentiate between the various causes which restrict tree growth. It is important to recognize that insects contribute greatly toward bringing about such conditions.

The mere reduction in the amount of wood produced in any one season is not the most serious phase of the problem, although it means a thinner layer of sapwood with a presumably corresponding reduction in the circulation, since sap flow is restricted to sapwood. Weakening of branches or leaves is usually evident first in the terminals, and is followed by greater susceptibility to both insect attack and fungous invasion. It is believed that a combination of these agencies, each of variable importance under different conditions, explains in considerable measure the many dying tips generally associated with what we consider a

[1]1925, Journal of Economic Entomology, 18:345–348.

"stagheaded" condition. We need more data as to the part insects play in producing such conditions and in some cases it is more than probable that the trouble had its inception years before there was any marked external evidence of injury. How much of this can be traced back to earlier attack by insects? We do know that such trees show a series of annual rings much thinner than the normal, a quarter or even a tenth of what they should be.

We have presented figures elsewhere showing that the shade trees of the country have a material value and it is our contention that this should be taken into account in estimating the economic importance of shade tree insects. We believe it much more economical to protect a tree from insect depredations than it is to replace such a tree with one of equal size. Furthermore, many of us cannot afford to wait for the growth of a good sized shade tree. We are obliged to profit by the foresight of an earlier generation.

Vice-President F. N. Wallace assumed the Chair.

VICE-PRESIDENT F. N. WALLACE: We will now call for a paper by F. F. Smith, H. J. Fisher and T. L. Guyton.

A PRELIMINARY REPORT ON THE CONTROL OF THE PINE TIP MOTH, *RHYACIONIA FRUSTRANA* (COMSTOCK).

By FLOYD F. SMITH, H. J. FISHER, and T. L. GUYTON,
Harrisburg, Pennsylvania

ABSTRACT

The pine tip moth (*Rhyacionia frustrana* Comstock) is established in certain small pine plantations and is a serious pest in evergreen nurseries. Various control measures were tried against this insect, some of which when applied to the egg stage were found to be practical.

Several acres of pine nursery were found seriously infested with the pine tip moth, *Rhyacionia frustrana* (Comst.), in 1928. The following pines were found to be heavily infested: Pitch pine (*Pinus rigida*), Austrian pine (*P. nigra-austriaca*), Japanese pine (*P. densiflora*), Jack pine (*P. banksiana*), Western yellow pine (*P. ponderosa*), Mugho pine (*P. mughus*), and Scotch pine (*P. sylvestris*). The Japanese black pine (*P. thunbergi*) was less severely infested. White pine (*P. strobus*) and several species of spruce growing nearby were not infested.

The injury is of two types. On host species having large buds and heavy growth, the injury is confined to the buds, while on species with small buds and weak growth the tips of the twigs as well as the buds are hollowed out. Both buds and hollowed twigs are killed when infested by the insects.

Briefly, the life history is as follows: The insect overwinters as pupae in the infested buds. There are two generations each year, the first adults appearing with the coming of warm weather in the spring. The first moths appeared May 2, 1928 and April 8, 1929, and the last ones were observed on June 3, 1928 and May 29, 1929, respectively. In 1928 the first moths of the second generation were found July 20 and the last ones August 9. In 1929 the first moths were taken July 9 and the last ones July 29. The adults emerging during the first 5 to 9 days of each generation are males and the females make up the large proportion of adults present during the last few days of each emergence period. The emergence in the second generation is over a period of about 3 weeks while the first generation moths are present from 4 to 7 weeks.

The unprotected eggs are deposited upon the buds, needles and twigs of the new growth. The emergence of the second generation over this comparatively short period and the exposed condition of the eggs make it practical to consider an insecticide directed toward killing the egg and early larval stages.

Our literature contains two references to methods of artificial control of the pine tip moths, *Rhyacionia* spp. Howard,[1] in 1925, reported that a 2% nicotine dust was very effective in killing the adults of *R. frustrana bushnelli* Busk. Gasow,[2] after studying the biology of the European pine shoot moth, *R. bouliana* (Schiff), in Germany, stated that an insecticide would be effective against the insect in the egg stage only.

The pine nursery in Pennsylvania infested with *R. frustrana* offered an opportunity for making control tests. The first trials which are included in Table 1 were based upon an attempt to kill the insect in any of its stages except the pupal. Later tests (Tables 2 and 3) included materials intended as ovicides and larvicides. The following tables give the materials used together with results:—

The injury to plants in plots of Table 2 escaped the notice of the superintendent of the nursery and all of the plants made a normal growth in 1929. High temperatures (94° Fah.) at the time of applying the first spray are probably responsible for the burning since increase of injury did not follow the later spray applications.

Mr. Fisher, who conducted the tests during 1929, reported that the first generation moths had a prolonged emergence period due to change-

[1]Howard, L. O. Report of the Entomologist, U. S. D. A. for 1924–1925. 35 pp. 1925.

[2]Gasow, H. Nachrichtenbl. deutsch. Pflanzenschutzdienst, V., No. 1, p. 5, 1925. (Abstr. Rev. Appl. Ent., Vol. 13 A. 1925.)

TABLE 1. RESULTS OF SPRAY TESTS DURING EMERGENCE OF FIRST GENERATION (*Rhyacionia frustrana*), 1928.

Material Used	Dates Sprayed	Number: Plants	Number: Shoots	Number: Clean Shoots	Number: Infested Shoots	Per cent Infested Shoots	Av. No. Infested Shoots per Plant	Per cent of Control	Condition of Plants July 23, 1928
Molasses 1–7; B. L. 40, 1–600; water	May 5, 7, 11, 14, 22, 29	58	1363	703	660	48.42	11.379	49.52	No difference in appearance of sprayed and check rows except for reduction in infested shoots.
Check		70	1646	68	1578	95.87	22.543		Due to almost complete killing of all tips, the plants have a brownish cast. Old green needles with covering of wax.
Lead Ars. 3 lb. to 50 gal. 1% Sunoco as spreader	May 5, 11, 14, 22, 29	54	1142	913	229	20.05	4.24	79.05	No difference in type or extent of growth except for decided staining of shoots and many of the older needles by the spray.
2% Volck	May 5, 11, 14, 22, 29	56	1176	1154	22	1.87	0.394	98.05	Growth is slightly shorter than uninfested checks. Needles shorter and more slender and appear more dense on plant. Color lighter green, bloom absent. Appearance not unhealthy, but that of fresh growth.
2% Sunoco	May 5, 11, 14, 22, 29	53	1113	905	208	18.68	3.924	80.61	No different from check in type and extent of growth but lacks bloom on needles.
Check		67	1415	59	1356	95.83	20.238		See check above.

TABLE 2. RESULTS OF SPRAY TESTS DURING EMERGENCE OF SECOND GENERATION (*Rhyacionia frustrana*), 1928.

Material Used	Dates Sprayed July	Dates Sprayed Aug.	Number Plants	Number Shoots	Number Clean Shoots	Number Infested Shoots	Per cent Infested Shoots	Av. No. Infested Shoots per Plant	Per cent of Control	Condition of Plants September 24, 1928
2% Volck	26	2 9	51	1038	1020	18	1.73	0.353	98.22	Very slight browning of needles in spots. Evidently the spray was unevenly applied here. General color of foliage lighter green than checks.
2% Volck	26	9	48	976	924	52	5.34	1.083	94.48	Same as above with less browning of needles.
2% Volck		2 9	47	953	814	139	14.47	2.957	85.06	Same as above.
2%Standard Oil Formula L 43.	26	2 9	70	1418	1390	28	1.97	.4	97.98	Spotted injury. Tips of needles brown and dry. Other plants entirely uninjured. Injury evidently more severe in shaded portions where drying was more slow.
Same as above	26	9	47	907	847	60	6.62	1.276	93.55	Same as above but less severe.
2% Standard Oil Formula L 280	26	2 9	50	1027	837	190	18.5	3.8	80.81	Trace of injury. Few needles on two plants near end of row are brown. Spraying finished at this end.
Same as above	26	9	53	1091	638	453	41.52	8.547	56.83	Color lighter than check. Needles uninjured.
2% Sunoco	26	2 9	63	1276	1150	126	9.87	2.0	89.9	Trace of browned needles on 3 plants. Color of foliage glossy and slightly lighter green than checks.
2% Sunoco	26	9	69	1411	896	513	36.35	7.434	62.46	No injury noted. Color same as above.
Check			64	1302	22	1280	98.31	20.000		Trees with brownish cast over green due to dead infested tips. Foliage with bloom present.
Check			32	656	31	625	95.4	19.71		Same as above check.
Average of checks							97.28	19.802		

TABLE 3. TESTS TO CONTROL *Rhyacionia frustrana*, 1929.

Material Used	Number: Plants	Number: Shoots	Number: Clean Shoots	Number: Infested Shoots	Per cent Infested Shoots	Av. No. Infested Shoots per Plant	Per cent of Control	
		Tests on *P. rigida*—First Generation*						Counts Made 6/27/29
Volck	39	819	783	36	4.39	.923	95.53	Curling of leaves and slight yellowing.
Sunoco	41	853	810	43	5.04	1.05	94.90	Trace of burning on few needles.
Scalecide	38	792	630	162	20.45	4.26	79.32	same
L-43	43	914	628	286	31.29	6.65	67.71	same
L-280	41	865	593	272	31.44	6.63	67.81	same
Check	40	840	16	824	98.10	20.60		
		Tests on *P. sylvestris*—First Generation*						Counts Made 6/28/29
Volck	42	1455	1427	28	1.92	.696	97.97	Trace of burning on a few needles.
Sunoco	40	1384	1351	33	2.38	.825	97.62	same
Scalecide	44	1551	1447	104	6.71	2.363	93.12	same
L-43	43	1505	1327	178	11.83	4.14	87.95	same
L-280	45	1575	1404	171	12.18	3.80	88.94	same
Check	40	1400	25	1375	98.21	34.375		
		Tests on *P. rigida*—Second Generation**						Counts Made 9/20/29
Volck	49	931	717	214	1.64	4.367	71.01	Curling and slight yellowing of needles.
Sunoco	55	1130	915	215	2.32	3.909	74.11	Trace of burning on few needles.
Scalecide	56	1176	890	286	11.61	5.107	66.18	same
L-43	53	1143	872	271	27.89	5.113	66.13	same
L-280	53	1120	760	360	33.25	6.792	55.68	same
Check	30	564	111	453	80.32	15.1		
		Tests on *P. sylvestris*—Second Generation**						Counts Made 9/20/29
Volck	42	1641	1603	38	2.32	0.904	97.62	Trace of burning on few needles.
Sunoco	45	1762	1733	29	1.64	0.644	98.30	same
Scalecide	36	1404	1141	263	11.61	7.305	80.77	same
L-43	30	1170	744	326	27.89	10.866	71.39	same
L-280	44	1672	1106	566	33.25	12.861	66.13	same
Check	26	1008	20	988	98.06	38.00		

All oils were used in 2% dilution.

In all cases the damage observed could be detected only after careful examination except in the case where Volck was used. Except for curling of the needles, the growth is not affected.

*Sprays were applied April 24, May 6, 17 and 21.

**Sprays were applied July 22 and 29.

able weather conditions. The timing of the first spray applied during the second generation emergence was not perfect since the first application was made July 22 while the first female moths were observed July 14. This series of tests should be compared with the 1928 tests of Table 2 in which the first spray was omitted. Resin fish oil soap was also included in this set of tests but gave no control.

From these tests we conclude that an insecticide applied at the proper time to the eggs and young larvae gives promise of satisfactory control. All promising materials used were oils.

MR. E. P. FELT: May I inquire whether that spray with oil might be equally effective with the European pine shoot moth.

MR. F. F. SMITH: The European pine shoot moth eggs are placed in the same relative position as are those of *frustrana*, and the description is the same, so I see no reason why it should not be equally effective.

President T. J. Headlee resumed the Chair.

PRESIDENT T. J. HEADLEE: The next paper is by L. H. Patch and D. J. Caffrey.

EXPERIMENTAL DETERMINATION OF CORN BORER DAMAGE

By L. H. PATCH and D. J. CAFFREY

(Paper not received)

PRESIDENT T. J. HEADLEE: The next paper is by C. J. Todd and F. L. Thomas.

NOTES ON THE SOUTHWESTERN CORN BORER, *DIATRAEA GRANDIOSELLA* DYAR

By C. J. TODD and F. L. THOMAS, *College Station, Texas*

ABSTRACT

The southwestern corn borer has been gradually spreading from Mexico, until now it has reached the northern border and is more than halfway across the Panhandle of Northwest Texas. It has been causing considerable injury to corn and has been found infesting several grain sorghums.

The specific determination of this insect, which is closely related to the larger corn stalk borer and the sugar cane moth borer, was for a long time more or less uncertain. Most of the references have been made under the name *Diatraea lineolata* (Walker), but according to Dyar and Heinrich,[1] Walker's species has not been known to be in this country.

The so-called southwestern corn borer, however, has been known to occur in the United States for more than ten years. It was first reported from Arizona, but probably came across the international border at several points, for it was found causing considerable injury over a large

[1]U. S. N. M., Vol. 71, Art. 19, p. 24, 1927.

part of the Trans-Pecos Region in Texas and the river valleys of Eastern New Mexico as early as 1922.[2]

The semi-arid condition of this region in Texas, which is south of New Mexico, has been the main factor in retarding the eastward spread of the borer as no corn is grown except along the river valleys, running north and south.

The distribution of the insect gradually extended northward in New Mexico until other favorable conditions were encountered, when it left the river valleys and entered Northwest Texas. In this region it has been making a steady advance in all directions. This advance has been greatly facilitated in recent years as ranch lands were being invaded by farms and the soil conditions in many cases found to be suitable for corn production.

The surveys which were made by workers engaged in cotton insect problems only partially covered the territory. They did not extend north of Farwell and Plainview although the borer was found at both of those points. It was also found on the north and west borders, but not actually in Lubbock County or in Terry County. The latter is a center for corn production in this section, the county seat having shipped out over a million bushels during 1928, according to P. C. Mangelsdorf, corn breeder of the Texas Station.

In October, 1929, a report and specimen of the southwestern corn borer were received from a correspondent at Dalhart, in the northwest corner of Texas. According to H. J. Clemmer, formerly superintendent of the Dry Land Field Station at that place, it appears that the infestation was first noted several years ago. Evidently the climatic conditions in the vicinity of Dalhart have not been sufficiently severe in the past few years for the borers to be killed out by the present farm practices.

The minimum temperature at Dalhart during each of the last three years has been below zero, Fahrenheit, with 9 degrees below being recorded in the winter of 1928–29. The normal temperature for December, the coldest month, is 32.2 degrees Fahrenheit.

The insect passed the winter as a larva in the tip of the corn root, and in 1929 transformed into the pupal stage the latter part of May. Twenty pupae from overwintered larvae remained in this stage an average of 14 days.

Examination of infested stalks on May 27 showed that 30 per cent of the overwintering larvae had pupated. A later examination made June 25 showed that between 95 and 100 per cent had become adults.

[2]L. O. Howard, Ent. Rept., U. S. D. A., 1923.

Only one record was made on oviposition. In this case the moth emerged June 7, was confined in a small cage without food or opportunity to mate, laid 187 eggs on June 9, and died June 10. The eggs laid in confinement and those found in the corn fields occurred in groups and singly. Normally the eggs are laid on the corn leaves.

There are at least two, and probably three, generations.

The first generation larvae attack the corn when the plants are small, work into the crown, and cut off the bud leaves. The senior author observed as many as thirteen young larvae in the crown of one plant. Later generations bore into and tunnel the stalks but do not enter the ears.

The injury produced by the worms is somewhat in proportion to the time when the corn is attacked and is worse in dry seasons. Some plants are ruined by the first generation of worms. The last generation does not reduce the yield as the plants, not previously attacked, have had opportunity to mature. They are weakened, however, and frequently break over.

Surveys made during the past two years show that greater injury as a result of the presence of the borer occurs in those areas that have been infested longest. In one field near Sudan in October, 1928, practically 100 per cent of the stalks were infested with one to three larvae, and 48 per cent of the stalks were broken over.

In the survey of 1929, five corn fields in Lamb and Bailey Counties had 96 to 100 per cent of the stalks infested. Only one field among those examined in these counties had as low as 70 per cent infestation. In these fields 22 to 41 per cent of the stalks were broken over. The average loss estimated by a number of farmers in the two counties mentioned, was 40 to 60 per cent, and the task of harvesting under such conditions is also greatly increased.

Other forage crops: namely, milo, feterita, hegari, orange-top cane, and kafir, have been found to be injured when adjacent to fields of heavily infested corn.

As yet no definite steps of a general nature have been taken to control or prevent the spread of this insect. Fall plowing of corn fields for the purpose of subjecting the hibernating larvae to greater exposure is not considered a wise practice by the farmers of that region as the disadvantages resulting from loss of soil by being blown away in the spring would supposedly more than offset any advantage which might follow.

The purpose in presenting these brief and rather incomplete notes is to call further attention to the fact that there is a corn borer in the southwest which has spread far from its native Mexican habitat and which is

apparently adapting itself to the conditions of a new environment. The insect has already proved to be a pest of considerable importance in Northwest Texas. Who can state where the ultimate limits of its distribution may be?

PRESIDENT T. J. HEADLEE: The next paper is by W. E. Hinds and Herbert Spencer.

PROGRESS IN THE UTILIZATION OF *TRICHOGRAMMA MINUTUM* IN CANE BORER CONTROL IN LOUISIANA DURING 1929

By W. E. HINDS and HERBERT SPENCER, *Louisiana Experiment Station*

ABSTRACT

This paper presents a brief review of progress in breeding work and in field colonization with *Trichogramma minutum*. It presents a comparison of the parasitism in sugarcane borer (*Diatraea saccharalis*) eggs in colonized areas as compared with natural, uncolonized development of this egg parasite. It also presents a definite case of effective borer control primarily by the utilization of this biological method.

During the past few years there has developed a widespread interest in the possibilities of increasing the usefulness of this cosmopolitan egg parasite, *Trichogramma minutum* Riley, for the control of the sugarcane borer and many other species of caterpillars of economic importance. So far as we have found, the first instance of such work dealing with the sugarcane borer (*Diatraea saccharalis* Fab.) was conducted in British Guiana in 1921 by L. D. Cleare.[1] In this work Cleare describes a method for securing eggs from Diatraea which were then exposed to attack by Trichogramma and the parasitized eggs distributed upon cane plantations.

The work which has been conducted during three seasons past at the Louisiana Experiment Station has been reported in part through previous publications.[2]

Improvements in Sitotroga egg production have centered around the handling of larger numbers of moths per unit containers, the influence

[1]Cleare, L. D., A Method for the Rearing of the Egg Parasites of the Sugarcane Moth Borers. Bulletin of Ent. Res., Volume 19, Part I, August 1928, and reprinted in the Agricultural Journal of British Guiana, Volume 11, No. 1, March 1929.

[2]Hinds and Spencer, Utilization of *Trichogramma minutum* for Control of the Sugarcane Borer. Journal of Economic Entomology, Volume 21, No. 2, April 1928, pages 273–278.

——————. Trichogramma Experiments in 1928 for Control of the Sugarcane Borer. Journal of Economic Entomology, Volume 22, No. 4, August, 1929, pages 633–636.

of starch, etc., upon oviposition and the influence of the position of the container, and of humidity, etc. Credit for this production work belongs particularly to Dr. Spencer who has planned and supervised the experiments. The jars now being used are round battery jars about 8 inches in height and 6 inches in diameter. These jars are covered with 20-mesh copper wire screening. The results as secured from 50 such jar lots handled under different conditions are shown in Table 1.

TABLE 1.—SITOTROGA EGG PRODUCTION BY VARIOUS METHODS

Period 1929	No. Jars	Approx. No. Moths[1]	Approx. Total Eggs[2]	Aver. No. Eggs per Female	Method of Securing Eggs
9/9–20	10	55,930	470,600	16.8	Jars inverted, without starch
9/9–25	22	101,700	1,392,000	27.2	Jars inverted, with starch
9/21–10/9	18	146,065	2,346,782	32.13	Jars upright, without starch

[1]The measurement of a large number of moths has shown an average of 92.4 moths per 1 c.c.
[2]The weight of a large number of eggs has shown an average of 51 eggs per 1 m.g.

These experiments show that moths gave the highest yield of eggs per female when confined in a large number (13,000 moths in a three-quart jar) and without the use of starch, or other material to incite oviposition. Practically twice as many eggs per female were deposited in these tests as in jars where they were inverted over starch.

To determine whether a large, or a small number, of moths per jar would influence the number of eggs deposited per moth, the records shown in Tables 2, 3 and 4 have been selected from the total of 18 jar records in the entire series of tests with the jars erect and without starch. From this series the highest average production was secured.

SITOTROGA EGG PRODUCTION TESTS

Number of eggs per female, with varying number of moths per jar.
(All jars kept upright, and without starch)

TABLE 2. Approximately 13,000 moths per jar

Exper. Jar No.	Approx. No. Moths	Total Eggs	Av. No. Eggs per Moth	Av. No. Eggs per Female
30	13,867	217,974	15.7	31.4
40	14,792	308,371	20.8	41.6
48	14,792	210,273	14.2	28.4
51	11,094	177,531	16.0	32.0
52	10,169	153,561	15.1	30.2
Totals & Averages	64,714 12,943 moths per jar	1,067,710	16.5	33.0

TABLE 3. Approximately 8,000 moths per jar

Exper. Jar No.	Approx. No. Moths	Total Eggs	Av. No. Eggs per Moth	Av. No. Eggs per Female
38	7,858	125,511	15.9	31.8
43	6,933	146,064	21.0	42.0
44	9,245	172,553	18.7	37.4
46	7,396	99,807	13.4	26.8
49	9,245	93,534	10.1	20.2
Totals	40,677	637,469	—	—
& Averages	8,135 moths per jar		15.67	31.3

TABLE 4. Approximately 5,000 moths per jar

Exper. Jar No.	Approx. No. Moths	Total Eggs	Av. No. Eggs per Moth	Av. No. Eggs per Female
31	4,622	68,926	14.9	29.8
34	4,622	52,435	11.3	22.6
37	5,084	78,361	15.4	30.8
39	3,235	72,598	22.4	44.8
45	4,622	74,001	16.0	32.0
50	5,547	90,780	16.4	32.8
Totals	27,732	437,119	—	—
& Averages	4,622 moths per jar		15.7	31.4

In the foregoing tables several records have been given each st representing "high," "medium" and "low" numbers of eggs per jar in order to average the conditions and results for each type of test. A comparison of the average number of eggs secured per female shows clearly that the best results were secured from the jars having a large number of moths per jar. The average in this set of tests was practically 13,000, or nearly three times as many as were in the "low" set. This fact indicates that there may be a considerable economy in handling large numbers of moths per jar rather than distributing the same number of moths between two or three jars.

During the past season only a "maintenance stock" of Trichogramma was bred during the winter season. This allowed the maximum reproduction of moths in the corn and the multiplication of Trichogramma was not begun until about the first of April. This allowed time enough for about six generations of wasps before they were needed in the fields. A multiplication of from four to six-fold is usually secured. The accumulation of a large stock of moth eggs is secured by holding the moth eggs, unparasitized, in the refrigerator at a temperature ranging from about 42 to 55 degrees F. The eggs keep well under these conditions for as much as a month and may then give perfect results when exposed to the parasites. It seems to us to be better to refrigerate the unparasitized eggs rather than to retard the development of the para-

sites, although this may be done also quite successfully, and does occur naturally during cool periods of weather.

While the average production of eggs per female Sitotroga is about 30, it has been found that selected, freshly emerged and mated females may give an average of twice this number. It is quite apparent therefore that in the miscellaneous collections made from the moth breeding rooms we are handling a large number of females which have previously deposited part, or all, of their eggs in the corn. This is probably not a disadvantage inasmuch as the infestation in the corn must be maintained at a high rate to continue the work effectively.

We believe that an improvement has been made also in our methods of securing the maturity, emergence, mating and field distribution of the wasps. We now hold the parasitized eggsheets in the Petrie dishes in the laboratory until the wasps emerge and mate. This allows emergence and mating under the most favorable conditions and with entire protection against the attacks of predators or the disastrous effects of unfavorable climatic conditons. When the majority of the wasps appear to be ready, they are released in the fields by the operator simply opening up the Petrie dish as he walks along the row and allowing the wasps to escape a few at a time. They are thus scattered through the area being colonized under favorable conditions for their immediate attack upon the borer eggs. Later emerging wasps from the same sheets may be liberated in the same manner at a later time.

In the work of 1929, approximately 10,000,000 Trichogrammas have been produced with moths reared from 100 bushels of corn. Of this wasp production approximately 1,500,000 have been utilized in field colonization work during the period from about May 28 to August 20.

The field colonization work has been conducted in three areas especially where close watch could be kept upon the conditions in the fields. The results from these principal field tests are shown in Table 4. The reader may draw therefrom his own conclusions as to the effectiveness of such colonizations in bringing about a high degree of destruction of the eggs of the sugarcane borer.

In regard to the data given in Table 5 it should be stated that in the location at Jeanerette it was not possible to make collections of eggs before the parasites were liberated at the colonization field. A very heavy infestation was developing in a field of stubble cane and liberation of 15,000 Trichogrammas on July 3 was followed by a peak of parasitization by the middle of August. In the check field, however, the Trichogramma did not destroy over 90% of the borer eggs until the 11th of September.

TABLE 5.—RESULTS OF FIELD COLONIZATIONS OF *Trichogramma minutum*, 1929, LOUISIANA EXPERIMENT STATION

Location, La.	Date Colonized	Approx. Number Parasites	Date Examined	% Parasitization Colonized Field	% Parasitization Check Field
Baton Rouge			4/12	0	0
(La. Sugar Station)			4/29	0	0
			6/3	0	0
	6/4–6	175,000			
	6/17	15,000	6/13–18	13	0
	7/3–22	130,000	7/15	25	1
			8/10	9.9	0
	8/12	178,000			
			8/28	25.1	29.7
			9/11	62.8	71.1
Cinclare			4/19	0	0
(7 cuts fronting	5/28	100,000	5/28	0	0
Miss. River)	6/11–12	23,000	6/11	29.0	0
	6/24	105,000	6/12	34	0
			7/22–23	30	1.5
			7/30	74.5	2.6
	8/14	280,000	8/14	90.3	19.1
			8/27	94.3	19.5
			9/13	96.4	39.8
Cinclare (at R. R.)			7/30	0.9	5.0
	8/2	85,000			
			8/27	63.8	19.5
Cinclare (Seed cuts)			8/2	0	5.0
	8/10	150,000			
			8/27	30.7	19.5
			9/13	72.0	39.8
Jeanerette	7/3	15,000			
			8/2	87.3	24.7
			8/14	99.7	27.3
			9/11	97.0	92.7

Some further observations upon the natural development of Trichogramma may be of interest. A series of examinations made during the week of August 12 to 19 covered some 30 fields distributed widely throughout the Sugarcane Belt. In these examinations from a collection of approximately 5,000 borer eggs taken outside of colonized areas, an average of 37% of the eggs were parasitized by Trichogramma. The abundance of borer infestation is indicated in a measure by the fact that in 15¼ hours of collection work 347 masses of borer eggs were found. This indicates what we would consider as a medium infestation. The only field examined on this trip where the parasitization was above 80% was the colonized field at Jeanerette, which is reported in the last portion of Table 5.

What we may consider as practically the peak of the natural occurrence of Trichogramma during the season of 1929 is shown by records secured during the period of September 10 to 13. In Table 6 following, the records are arranged according to the variety and time of planting

of the cane. It is not yet certain whether the variation in per cent of eggs parasitized shown in this table has any real significance.

TABLE 6.—TRICHOGRAMMA OCCURRENCE IN FIELDS OF VARIOUS VARIETIES OF CANE, SEPTEMBER 10-13, 1929

(Arranged in order of borer infestation)

Variety and Planting	Number Eggs Examined	Approximate Number Parasitized	Per cent Eggs Parasitized
P O J 213—Plant	10,637	9,818	92.3
P O J 213—Stubble	3,438	2,905	84.5
P O J 36—Stubble	3,202	3,069	92.8
P O J 234—Plant	82*	13	15.8
P O J 36—Plant	617	560	90.8
P O J 234—Stubble	1,535	1,349	88.0
La. Purple	335	111	33.1
Totals and Average	19,846	17,825	90.0

*This number is too small to be considered as significant.

The figures shown above, indicating 90% of borer eggs destroyed by Trichogramma during the period of September 10 to 13, agrees closely with the records for preceding years and may be considered as practically the average peak of parasitization. This high percentage was reached from 4 to 6 weeks earlier in at least two of the colonized fields.

For several years it has been noted that the heaviest borer infestation occurring in Louisiana has been along the western bank of the Mississippi River and ranging from opposite Baton Rouge for nearly 50 miles southward.. Along this territory the borer has, in some cases, so injured the cane that it was not worth harvesting. We have reason to expect, therefore, that the heaviest areas of infestation may be found in these "front cuts" as they are called through this territory. Some of these areas were selected, therefore, for our field colonization work in 1929. Cinclare Plantations, referred to in the foregoing tables, are located nearly opposite Baton Rouge—across the River. We cite the work done here as a fairly clear-cut case of biological control of the sugarcane borer.

In the season of 1927 at Cinclare Plantations certain front cuts of cane were very heavily infested by the borer early in the season. From the growth of this cane up to the middle of July the owners had reason to expect a yield of approximately 25 tons per acre as it was P. O. J. 234-plant cane. Before harvesting time the damage done by the borer resulted in the breaking down and killing of nearly half the tops throughout this area. The final yield secured amounted to only 14.75 tons of cane per acre and in this the sucrose averaged only 8%, whereas the average in this variety of cane, where borer damage was much lighter,

was usually between 13 and 14%. It was estimated that 43% of the tops had been killed by the borer and an examination of the eyes (or buds) of this cane showed that at least 25% of them had been killed and fully two-thirds of the joints were perforated by the borers.

In comparison with the foregoing conditions of 1927, the areas selected for Trichogramma colonization in 1929 were of the same P. O. J. 234 variety, but stubble, instead of plant cane. Usually with this variety also the plant crop yields considerably better than does the stubble crop. The borer infestation in this area in 1929 was heavy from the beginning of the season and promised to result in as severe borer infestation as had occurred in the similarly located cuts referred to above in 1927.

The colonization work done with Trichogramma in this area, of some 10 acres of cane, is shown in Table 4 under the heading of "Cinclare, 7 cuts fronting Mississippi River." The steady increase in the parsitization of borer eggs shown in Table 4 for this area indicates very conclusively the rapid and effective development of Trichogramma from the liberations which were made.

The final records from this field show an average yield of 19.12 tons of cane per acre with an average of 12.85% of sucrose. While this yield is not high, it is fairly normal for a stubble crop of this variety of cane. The condition of the cane at the end of the season was not one of extremely heavy borer infestation. The yield secured may be considered practically average for a condition of moderate borer infestation. The distribution of parasites which was largely responsible for the control of the borers in this case amounted to a little more than 20,000 per acre, liberated between May 28 and June 24. The large liberation of 280,000 parasites on August 14 was made after 90% of the borer eggs were already being parasitized. We believe that this is the first case where a heavy initial borer infestation has been effectively checked by biological methods of control in Louisiana so that a profitable crop of cane was secured.

Adjournment: 5:10 P. M.

Proceedings of the First Annual Paper-Reading Session of the Eastern Branch of the American Association of Economic Entomologists

This meeting of the Eastern Branch was held at the American Museum of Natural History, New York City, on November 21 and 22, 1929. The session was called to order by Chairman Cory, and Dr. L. O. Howard opened the meeting with observations on the development of economic entomology in this country since the first meeting of the American Association of Economic Entomologists held in Brooklyn, some thirty-five years ago, where the attendance was relatively small.

PART I. BUSINESS PROCEEDINGS

Chairman Cory appointed a nominating committee consisting of P. J. Parrott, A. F. Burgess and P. J. Chapman.

The following report of the Secretary was read and accepted.

Report of Secretary

"On August 16, 1928, the Northeastern Entomologists and the Eastern Branch of the American Association of Economic Entomologists met at Ithaca. Dr. T. J. Headlee, chairman of a special committee appointed at Winchester, Virginia, in the summer of 1927 charged with the duty of drawing up and presenting a petition to the American Association of Economic Entomologists for the formation of an Eastern Branch, reported that this committee had drawn up this petition and caused it to be presented to the Association at its annual convention in Nashville and that the request had been granted.

"At the Ithaca meeting on August 16, 1928, Mr. E. N. Cory was elected president and Mr. H. B. Weiss was elected secretary-treasurer. Three members at large, Mr. A. F. Burgess, Dr. E. P. Felt and Dr. T. J. Headlee, were appointed by the chair and these members together with the two officers constituted a committee charged with the duty of drawing up a plan of organization. Such a plan was drawn up under the title, "Articles of Agreement" and submitted on March 12, 1929, to the members of the American Association of Economic Entomologists living within the territory covered by the Eastern Branch.

"The criticisms and suggestions received as a result of this action were incorporated in a revised set of Articles of Agreement which was submitted again to the members of the parent organization living within Eastern Branch territory. This was done on October 5, 1929, and the articles will become effective upon adoption by the Eastern Branch and upon approval by the executive committee of the American Association of Economic Entomologists.

"On July 15, 1929, a card was sent to members of the parent organizati the Eastern Branch territory asking them to keep the November meeting date in and to present the results of their summer research work.

"On October 5, 1929, letters were sent to approximately 600 entomologis within Eastern Branch territory advising them of the November meeting, enclosing the Articles of Agreement and asking for titles of papers to be read at the meeting.

"On November 8 a program was mailed to the same 600 entomologists and they were invited to join the Branch."

On motion duly seconded and carried, the Articles of Agreement governing the Eastern Branch were adopted.

ARTICLES OF AGREEMENT GOVERNING THE EASTERN BRANCH OF THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

ARTICLE 1. This Organization shall be known as the Eastern Branch of the American Association of Economic Entomologists.

ARTICLE 2. Its object shall be to advance entomology in all its phases by affording opportunities for the presentation of new facts by exchange of experiences, by the discussion of entomological topics, by the announcement of projects and by cooperation with related activities.

ARTICLE 3. Membership in this branch shall be confined to the territory embracing West Virginia, Virginia, District of Columbia, Maryland, Delaware, Pennsylvania, New Jersey, New York, Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire and Maine, and the Canadian Provinces of Ontario, New Brunswick, Quebec, Nova Scotia and Prince Edward Island.

ARTICLE 4. All members of the American Association of Economic Entomologists in the territory named in Article 3, shall become members of the Eastern Branch automatically on the payment of the dues provided in Article 8, of this agreement. All persons interested in any phase of entomology in this territory may become affiliated members of this Branch by being nominated at a regular meeting and elected by a two-thirds vote of the members present. Affiliated members shall have the same privileges and be subject to the same dues as members but shall not hold office. Any affiliated member who shall become a member of the American Association of Economic Entomologists shall automatically become a member of this Branch.

ARTICLE 5. The officers shall consist of a chairman and a vice-chairman who shall be elected annually and a secretary-treasurer who shall be elected for a term of three years upon recommendation by a nominating committee or upon nomination from the floor. The above officers shall act as the executive committee and shall pass on all urgent matters that cannot be deferred until the annual meeting. The chairman shall not hold office for two consecutive terms.

ARTICLE 6. The annual meeting shall be held at such time and place as may be decided by the Branch at the previous annual meeting and special meetings may be called by order of the executive committee. Twenty members shall constitute a quorum for the transaction of business.

ARTICLE 7. All proposed alterations or amendments to this agreement shall be referred to a committee of three at a regular meeting and must be approved by the executive committee of the American Association of Economic Entomologists. After a report has been made by the committee, the alterations or amendments may be adopted by a two-thirds vote of the members present; provided, that a written notice of the proposed changes has been sent to every member of the Branch at least one month prior to the date of action.

ARTICLE 8. The annual dues of all members shall be $2 payable in advance and shall not include subscription to the JOURNAL OF ECONOMIC ENTOMOLOGY. The

annual dues after postage and similar items have been deducted shall be used in meeting the additional cost of publishing the papers read before the Branch in the JOURNAL OF ECONOMIC ENTOMOLOGY.

ARTICLE 9. Robert's Rules of Order shall govern the sessions.

ARTICLE 10. This agreement shall become effective on approval by the Eastern Branch at a regular meeting and on approval by the executive committee of the American Association of Economic Entomologists.

The Secretary proposed the following names for affiliated membership and they were duly elected:

William T. Davis, Staten Island, N. Y.
Norman H. Stewart, Bucknell University, Lewisburg, Pa.
L. R. Colt, Jr., Chestnut Hill, Philadelphia, Pa.
Fred M. Schott, Bergenfield, N. J.
Avila Blanchard, Providence, R. I.
George P. Engelhardt, Brooklyn, N. Y.
O. K. Courtney, Camden, N. J.
Howard Notman, Brooklyn, N. Y.
George Wishart, Dominion Parasite Laboratory, Belleville, Ont., Canada.
Marcus S. Crane, Caldwell, N. J.
John Glassford, Baltimore, Md.

The executive committee was authorized to select the time and place of the next winter meeting.

The desirability of a summer meeting was discussed and it seemed to be the general opinion that such a session should be a leisurely one, with few papers, ample time for discussion, in beautiful surroundings. Long automobile tours were frowned upon.

The following resolution was adopted:

RESOLVED, That Harry B. Weiss, Secretary-Treasurer of the Eastern Branch, is hereby authorized and empowered to collect moneys, pay bills, sign checks and otherwise conduct the financial affairs of the Eastern Branch.

FINAL BUSINESS SESSION

Chairman Cory called for the report of the nominating committee, which made the following nominations:

For Chairman, C. H. Hadley

For Vice Chairman, Lawson Caesar.

The report of the nominating committee was accepted and Mr. Hadley and Mr. Caesar were duly elected for the coming year.

Dr. T. J. Headlee outlined the purpose of the Eastern Branch and spoke of the necessity of publishing the proceedings of the Branch in an extra number of the JOURNAL. He thought the expense should be born by the Branch and moved that the chairman appoint a committee whose business it would be to raise the money and devise a scheme for future publication. This motion was seconded by Mr. Hadley and carried.

Mr. Hadley took the chair and later appointed the following committee: V. I. Safro, Chairman, William Moore, S. W. Bromley, J. G. Sanders, I. L. Ressler.

A resolution was passed, extending greetings to Mr. C. W. Collins and wishes for his speedy recovery. The secretary was instructed to telegraph the resolution to Mr. Collins at Melrose Highlands, Massachusetts.

The Secretary proposed R. W. Sherman, Camden, N. J., and L. A. Kohler, Clifton, N. J., for affiliated membership and they were duly elected.

The Secretary was instructed to convey the sincere thanks of the Eastern Branch to the American Museum of Natural History for providing a meeting place and accommodations for the members and friends in attendance.

HARRY B. WEISS,
Secretary-Treasurer

The following members and visitors were present:

Allen, H. W., Moorestown, N. J.
Ashworth, J. T., New Haven, Conn.
Back, E. A., Washington, D. C.
Badertscher, A. E., New Brunswick, N.J.
Bailey, H. L., Bradford, Vt.
Barnes, Parker T., Palmyra, N. J.
Beckwith, C. S., Pemberton, N. J.
Blauvelt, W. E., Ithaca, N. Y.
Brigham, Theodore, New Haven, Conn.
Britton, W. E., New Haven, Conn.
Bromley, S. W., Stamford, Conn.
Brown, F. Martin, Avon, Conn.
Brown, Hazel H., Avon, Conn.
Burdette, R. C., New Brunswick, N. J.
Burgess, A. F., Melrose, Mass.
Cagle, L. R., Blacksburg, Va.
Campbell, F. L., Washington, D. C.
Chapman, P. J., Norfolk, Va.
Cory, E. N., College Park, Md.
Cotton, R. T., Washington, D. C.
Courtney, O. K., Camden, N. J.
Cronin, T. C., New York, N. Y.
Crosby, C. R., Ithaca, N. Y.
Curran, C. H., New York, N. Y.
Daniel, D. M., Geneva, N. Y.
Dills, L. E., Ithaca, N. Y.
Dobroscky, Irene D., Yonkers, N. Y.
Driggers, Byrley F., New Brunswick, N.J.
Dyce, E. J., Guelph, Canada.
Engelhardt, G. P., Brooklyn, N. Y.
Felt, E. P., Stamford, Conn.
Filmer, Robert S., New Brunswick, N. J.
Fink, D. E., Philadelphia, Pa.
Fox, Henry, Moorestown, N. J.
Friend, R. B., New Haven, Conn.
Garman, Philip, New Haven, Conn.
Ginsburg, J. M., New Brunswick, N. J.
Glaser, R. W., Princeton, N. J.
Glassford, John, Baltimore, Md.
Grant, D. H., Berkeley Heights, N. J.
Gray, John, Ithaca, N. Y.
Hadley, C. H., Camden, N. J.
Hallock, Harold C., Westbury, N. Y.
Hamilton, C. C., New Brunswick, N. J.
Harman, S. W., Geneva, N. Y.
Hartzell, Albert, Yonkers, N. Y.
Hartzell, F. Z., Geneva, N. Y.
Headlee, Thomas J., New Brunswick, N.J.
Herrick, Glenn W., Ithaca, N. Y.
Hervey, G. E. R., Geneva, N. Y.
Hoerner, John L., Ft. Collins, Colorado.
Horsfall, J. L., New York, N. Y.
Howard, L. O., Washington, D. C.
Huckett, H. C., Riverhead, N. Y.
Hutson, Ray, New Brunswick, N. J.
Inman, M. T., Nyack, N. Y.
Johnson, J. Peter, Shelton, Conn.
Johnson, V. A., Camden, N. J.
Jones, Thomas H., Melrose Highlands, Mass.
King, J. L., Riverton, N. J.
Kisliuk, Max, Philadelphia, Pa.
Knull, J. N., Harrisburg, Pa.
Kohler, Louis, Clifton, N. J.
Langford, George S., College Park, Md.
Larrimer, W. H., Washington, D. C.
Lipp, J. W., Moorestown, N. J.

Lutz, F. E., New York, N. Y.
Manter, J. A., Storrs, Conn.
McClendon, S. E., Thomasville, Ga.
McConnell, H. S., College Park, Md.
McFarland, B. W., New Haven, Conn.
McPhail, M., Washington, D. C.
Metzger, F. W., Moorestown, N. J.
Moore, William, New York, N. Y.
Mutchler, A. J., New York, N. Y.
Nelson, Franklin C., Roselle, N. J.
Nicolaou, John Hadji, New Brunswick, N. J.
Olsen, C. E., Nyack, N. Y.
Parrott, P. J., Geneva, N. Y.
Peairs, L. M., Morgantown, W. Va.
Phillips, E. F., Ithaca, N. Y.
Phillips, Saul, Albany, N. Y.
Poos, F. W., Washington, D. C.
Porter, B. A., Washington, D. C.
Rex, Edgar G., Trenton, N. J.
Richmond E. Avery, Amherst, Mass.
Ryberg, M. E., Yonkers, N. Y.
Safro, V. I., New York, N. Y.
Schoene, W. J., Blacksburg, Va.
Schread, John C., New Haven, Conn.
Seeley, R. M., New York, N. Y.
Sherman, John D., Mt. Vernon, N. Y.
Sherman, R. W., Camden, N. J.
Slocum, B. A., Ithaca, N. Y.
Smith, Floyd F., Washington, D. C.
Smith, George A., Boston, Mass.
Smith, L. B., Moorestown, N. J.
Spruijt, F. J., Babylon, N. Y.
Stearns, L. A., Newark, Del.
Stewart, N. H., Lewisburg, Pa.
Stockwell, C. W., Camden, N. J.
Tischler, Nathaniel, Bristol, Pa.
Turner, Neely, New Haven, Conn.
Van Leeuwen, E. R., Riverton, N. J.
Wade, J. S., Washington, D. C.
Wadley, F. M., Washington, D. C.
Walden, B. H., New Haven, Conn.
Weigel, C. A., Washington, D. C.
Weiss, Harry B., New Brunswick, N. J.
Williams, L. L., Dover, Del.
Wishart, George, Belleville, Ont., Can.
Worthley, H. N., State College, Pa.
Zappe, M. P., New Haven, Conn.

PART II. PAPERS

Thursday Morning, November 21, 1929

IMPROVEMENTS IN SPRAYING EQUIPMENT

By A. F. Burgess, *Plant Quarantine and Control Administration, Melrose Highlands, Mass.*

Abstract

The development of high power sprayers is briefly traced with particular reference to equipment that has been found most satisfactory on gipsy moth work. Reference is made to recent construction of a power take-off for light motor trucks which has been operated for one season with excellent results. Working pressures up to 1,000 pounds can be used where hose lines of 6,000 feet are required.

The control of most leaf-eating and many sucking insects is accomplished by different types of insecticidal treatment, and spraying forms an important part of most control programs. Of necessity, the nature of the crop to be treated and the conditions under which it is grown are of equal importance with the habits of the pest that is being fought. The methods covered in this paper apply more especially to shade and forest tree problems but certain adaptations are doubtless feasible for other types of growth requiring treatment.

Spraying machinery has been gradually improved during the last thirty years, the certainty of results has been increased, and the cost of treatment kept within reasonable limits in spite of a steady increase in the price of labor and machinery. During the nineties hand pumps

mounted on barrels or hogsheads were used in most spraying operations but efforts were made, particularly in Massachusetts and New York, to employ steam and gasoline engines to drive the pumps. Motive power was furnished by horses and the amount of spray that could be applied daily was frequently limited by this slow means of locomotion.

In the Year Book of the United States Department of Agriculture for 1896, Doctor L. O. Howard described in considerable detail different types of steam apparatus that were being used for spraying. One of these spraying outfits was used in Prospect Park, Brooklyn, New York, by Mr. J. A. Pettigrew who was Superintendent of parks. Later a similar machine was used in the Boston parks by Mr. Pettigrew and proved much more satisfactory than the hand pump sprayers. An outfit that was more compact was used by Doctor E. B. Southwick, Entomologist of the Department of Public Parks, New York City. The motor and pump weighed about 300 pounds and were mounted in the front of an ordinary one horse express wagon with a 100-gallon tank in the rear. The motor, known as a "Daimler," which at that time was used extensively in naphtha launches, supplied the power. This outfit was capable of developing 60 pounds pressure, ¼'' hose was used and ladders were required. Doctor Howard stated, "It is almost noiseless and is used with the utmost safety on the Central Park drives, where the slight noise made by the motor is not noticed by the horses. Readers of this article acquainted with the Mall in Central Park will appreciate the havoc which might be created by a noisy steam engine." Conditions have changed in many respects since that time.

By 1909 several improved sprayers were placed on the market for use in treating shade, roadside and park trees. They were horse drawn outfits, with 400-gallon tanks mounted in front of a gasoline engine and pump which was placed over the rear axle of the running gear. The following year a 3-ton motor truck was used by the Forestry Department of the State of Massachusetts, the tank being mounted behind the pump, the power being supplied from the automobile engine. The spraying unit was removable so that the truck could be used for other purposes after the spraying season. In 1915 a machine of this type was built under contract for the Gipsy Moth Division of the Bureau of Entomology. Later, 5-ton trucks were used, and heavier pumps were installed in order to maintain higher pressures. Along with these developments came the necessity of using hose and nozzles that would deliver the spray material more rapidly. 1'' hose capable of handling working pressures up to a thousand pounds was finally used, also specially constructed couplings that would not pull out when long lengths of

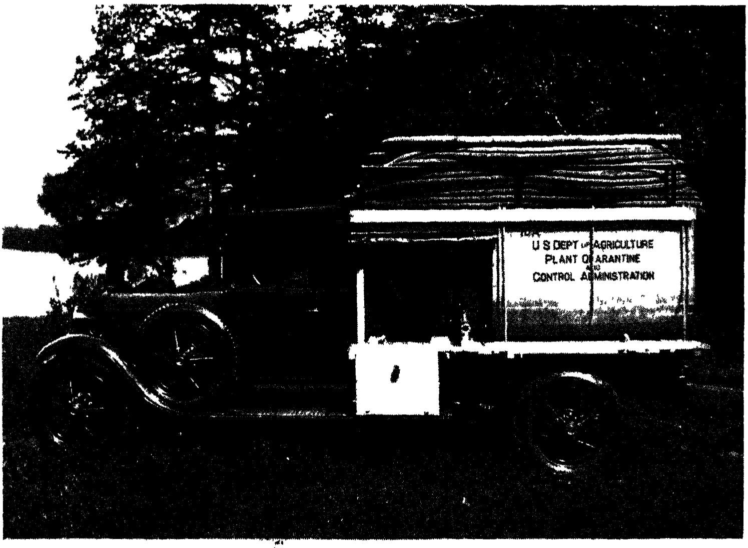
hose were dragged during the spraying operations. A new type of nozzle known as the Worthley nozzle was developed by means of which a mist spray could be delivered evenly over tall trees without climbing. This nozzle was devised by Mr. L. H. Worthley while connected with the gipsy moth project and he was also responsible for many of the improvements in the sprayers and other equipment which has already been mentioned.

In 1926 the most effective high power sprayer used on the gipsy moth work was procured by the Bureau of Entomology. It was capable of delivering more than a thousand pounds working pressure and had been improved in many respects over the machines previously used. The necessity for such high pressure is due to the fact that on many types of work long lines of hose are required ranging from 2500 to 6000 feet. Absence of passable roads and the desirability of placing the sprayer at the water supply make it necessary to use long hose lines. While nozzle pressure of about 300 pounds is ordinarily sufficient for solid stream spraying, the friction in the long hose line and the difference in elevation between the level of the sprayer and the nozzle at the end of the line, sometimes amounting to several hundred feet, made it necessary for a machine to develop this high working pressure.

In treating woodland areas where the water supply was not conveniently located, experience has shown that the cost of treatment could be reduced by locating a small gasoline pumping engine at the water supply and filling the tank a thousand or more feet away by this means. While this method made it possible to increase the amount of spray material that could be applied per day, it was found that the tank filled rather slowly when this plan was used. In order to overcome this difficulty and further increase the daily output of the sprayers, tests were made to determine the feasibility of placing a partition in the tank so as to divide it into two equal parts. This was arranged so that the spray mixture could be pumped from one compartment while the other compartment was being filled and the poison mixed. This plan has worked very satisfactorily and has made it possible to increase the output and the acreage sprayed about 30%. Other improvements have constantly been made to increase the efficiency of spraying work.

The use of fish oil as a sticker which was worked out by Mr. C. E. Hood, of the Gipsy Moth Laboratory, has resulted in making the spray adhere more firmly to the foliage and is of special advantage during seasons when the rain fall is heavy. Rearrangement of many details in handling the spraying work has also increased the daily acreage that can be treated.

Plate 5



High power sprayer used in Gipsy moth work.

In 1925 an attempt was made to develop a light sprayer, using a 1-ton truck which could be placed in locations where a heavier truck could not be operated to the best advantage. There were in operation at the time a number of different types of spraying units which included tank and gasoline engine, that could be placed in a motor truck and used for this purpose, but they were low pressure outfits and it was desired to have a unit that could be mounted on a truck chassis and take its power direct from the automobile drive shaft. This would eliminate the need of a gasoline engine in the spraying unit, and by having the latter removable it would be possible to substitute a commercial body and use the truck for other purposes after the spraying season was over. Several sprayers of this sort have been built and used with satisfactory results. In order to properly adjust the weight of the unit when the tank was filled, to the capacity of the truck, a 200-gallon tank was used. This sprayer would not develop more than 450 pounds pressure, and while it was very satisfactory in cases where long lines of hose were not required, it was inadequate to meet the needs of some of the most difficult spraying jobs that had to be done. In 1927 a United States service patent was granted on certain features of this machine which makes it possible for it to be constructed by anyone without payment of royalty.

During the past year an attempt has been made to improve this type of sprayer and to increase the power that could be delivered to the pump in order to make it more efficient. This has been accomplished by adding an auxiliary shaft to the power take-off and as a result it has been possible to operate the machine up to a thousand pounds working pressure during the past season. Application has been made for United States service patents covering this device, and if allowed will enable any manufacturer to place this machine on the market without payment of royalty.

The essential points of the take-off are illustrated in the attached drawing and the truck together with the sprayer attachment forms a very useful and practical means of conducting spraying work on shade or forest trees. During the past season this machine has been in operation continuously on some of the most difficult treatment work that has been undertaken. Pressures ranging from 900 to 1000 pounds have been used constantly on hose lines from 3000 to 6000 feet in length. Owing to the light weight of the machine it is possible to place it in many locations where a heavy machine could not be driven and the results have been excellent.

The take-off is so arranged that by making one minor adjustment trees can be satisfactorily sprayed when the truck is moving as well as when it is stationary. This equipment gives promise of being very useful for spraying work and it should be possible to manufacture it at a price that would be within reach of towns or cities or companies or individuals who have spraying work to do. After the spraying season is over, by substituting a platform body, the truck can be used for other purposes.

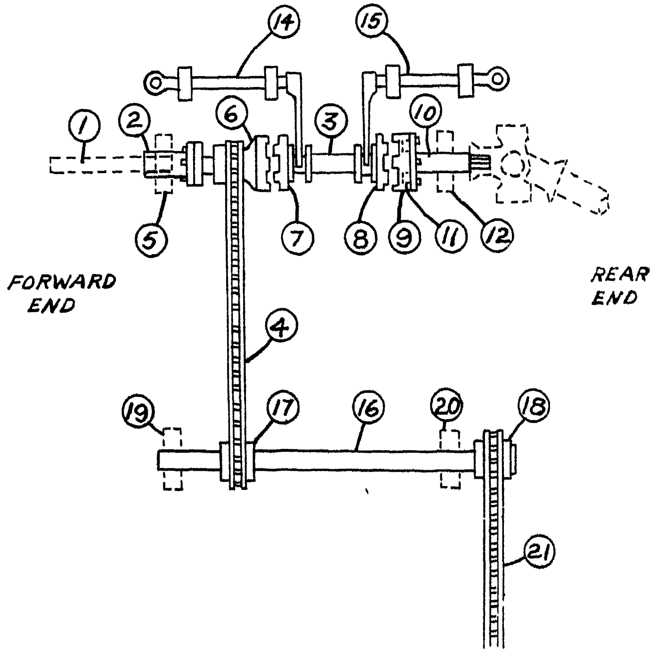


Fig. 16.—Essentials of take-off.

The improvements cited have been the result of tests and observations made by officials and field men connected with the Gipsy Moth project. D. M. Rogers, L. H. Worthley, and H. L. McIntyre contributed much to the progress that has been made, and H. L. Blaisdell and W. H. Campbell have given invaluable assistance in perfecting the equipment and developing the light sprayer above described. During the past few years we have had the advice and cooperation of the Office of Public Roads of the Department of Agriculture, and the interest and help rendered by Mr. S. J. Dennis of that office have been of special value.

SHADE TREE INSECTS IN 1929

By Dr. E. P. Felt and S. W. Bromley,
Bartlett Tree Research Laboratories, Stamford, Conn.

Abstract

The Norway maple leaf stem miner, *Nepticula sericopeza* Zell., is somewhat generally distributed in southeastern New York and southwestern New England. Spraying with a nicotine molasses soap combination in May apparently gives excellent control. The red cedar aphis, *Lachnus sabinae* Gill., provided an excellent outdoor demonstration of injuries earlier associated provisionally with this species. The hackberry nipple gall, *Pachypsylla mamma* Riley, and the hackberry bud gall, *Pachypsylla gemma* Riley, are both common on hackberry. The former is readily controlled with a nicotine molasses spray applied about the middle of May and the latter with the same materials applied about June 10th. The insecticide kills many adults and apparently destroys the eggs. The knotty oak galls, *Andricus punctatus* Bass, *A. cornigerus* O. S., and *A. clavigerus* Ashm. are common on the red oak, pin oak and willow oak respectively, in some instances causing serious injury. The alternate generation of the former two develops in a small blister leaf gall. The hackberry leaf aphid, *Myzocallis fumipennellus* Fitch, is responsible for a very general yellowish spotting and browning of hickory leaves in early fall, in some cases, most of the leaves being killed. The bronze birch borer, *Agrilus anxius* Gory, and the two-lined chestnut borer, *Agrilus bilineatus* Weber, are generally distributed pests. Available data show that feeding of birches frequently enables the trees to outgrow somewhat serious infestations. Work by the two-lined chestnut borer is very frequent on trees indirectly injured by grading or building operations. The filbert bud mite, *Eriophyes avellanae* Nal., produces greatly enlarged buds on European filberts and has been associated with some severe injury. A paste of calcium cyanide and castor oil applied to areas infested by the linden borer, *Saperda vestita* Say, have given very encouraging results.

The following notes relate to some of the more interesting insects which have come under observation and record during the past season.

The Norway maple leaf stem miner, *Nepticula sericopeza* Zell., kindly determined by Dr. August Busck of the United States National Museum, was observed at Stamford, Conn. June 16, 1928. Attention was called to it then on account of there being an extremely heavy leaf fall, the infestation probably reaching 25 per cent on a tree over 60 feet high, and at the time of observation, some 10 per cent of the leaves then remaining were found infested, the distribution of the borer being very uniform, throughout the tree. This is a European insect. Dr. Busck informs us that it is recorded as mining the young fruit of Acer, causing premature dropping. It presumably has the same habit in this country, though this has not been observed.

There is little about the fallen leaf to suggest the real cause of the trouble. There is a slight enlargement of the basal half inch of the leaf stalk, the part next the twig, with a somewhat evident sooty discoloration

and most characteristic of all a minute white speck, presumably dried sap, indicating the point of injury. The caterpillar is semi-transparent, only about a sixteenth of an inch long, and the borings very obscure. The larva has a light brown, semi-transparent head, the body segments are smooth, whitish, transparent, and the posterior segment is somewhat produced along the median line, with sublateral oblique chitinous rods or spines and also a submedian chitinous structure terminating in two curved rods. Infestations were definitely located last year at Stamford and Darien, Conn., White Plains and New Hamburg, N. Y. The insect is probably somewhat widely distributed.

Moths were observed on the tree May 13th and 22nd to 28, 1929 and some of these caged produced the type of injury previously asso-associated with this insect. Apparently a very satisfactory degree of control was obtained by spraying with a solution composed of three pounds, eight ounces of Kirkman's soap, one-half pint of Black Leaf 40 and two quarts B & O Molasses to 40 gallons. The first treatment was given May 3 and a second May 22. A number of dead moths were observed after the spraying and whereas the infestation in 1928 was estimated at 25 per cent, that of 1929 was less than one per cent, the presumption being that a considerable proportion of this reduction was due to the spraying.

The red cedar aphis, *Lachnus sabinae* Gill., determined through the courtesy of Dr. Gillette, was less abundant the past season than in 1928. One seriously infested cedar was found May 22, 1929 and kept under observation throughout the season. Severe injury to this tree, which, incidentally, was in excellent condition in the spring, was noted June 21, some 75 per cent of the foliage being browned. June 24th, there had been a great reduction in the aphid population and winged lice were observed the 26th. Most of the insects leave the cedars in early midsummer. July 17, some 80 per cent of the foliage was dead. These conditions practically duplicate results obtained in the insectary and observed here and there in the field the preceding season and clearly establish the ability of this plant louse to cause serious injury to red cedars. The aphids harmonize so closely with the twigs upon which they cluster that infestations are not easily seen. The insects have usually disappeared before the injury is marked. Numerous attending ants serve as guides to the clusters, which in some cases may be an inch or even two inches long and in severe infestations there may be several such clusters on a branchlet some eight inches long.

The complete life cycle of this species remains to be worked out, although it is known that small numbers appear upon the cedars in the

fall and possibly winter upon the trees. It is doubtful whether this be the normal habit, since a very careful search for eggs and hibernating aphids last fall and early this spring gave negative results. Thorough spraying with a nicotine soap solution on the appearance of the aphids in the spring has given excellent control.

Hackberry nipple gall, *Pachypsylla mamma* Riley. This species ordinarily winters in the adult condition within the galls, though some may issue in the fall, a few such appearing in cages October 19, 1928. The adults were numerous on the trees at the time the young leaves began to appear, namely April 26, 1929 and continued in some numbers to mid-May. The eggs are similar to those of the pear psylla, except that they are whitish and are deposited with the long diameter parallel to the surface, commonly along the veins of the young leaves or upon blossom clusters, in ill-defined groups of 10 to 20 or even 30 or 40, and sometimes singly. Eggs were observed May 24, 1929 standing almost perpendicular to the leaf surface, the presumably anterior thicker end next the leaf, the free end tapering to a slender point and apically with a bristle-like appendage about one-fourth the diameter of the egg. The leaf at the point of egg attachment shows a distinct brownish discoloration and apparently a development of a thickly setose collar of plant tissues which appears to be growing up around the insect and around this collar there is a lighter area like a halo or ring. This is presumably the beginning of the gall. Four days later, numerous small holes, suggestive of spots where young psyllids may have started to establish themselves, were observed upon a number of leaves. In a few cases, the holes were surrounded by a circle of short plant hairs. June 5 leaf galls, approximately one-eighth of an inch in diameter and one-eighth of an inch high, were observed on a hackberry at Great Neck, Long Island, N. Y. The tiny nymphs were apparently motionless. A tree, badly infested with this psyllid, was sprayed April 30, 1929 with 3½ pounds of molasses, one-fourth pint of Black Leaf 40 and 10 ozs. of lux soap flakes to 25 gallons of water. A second spraying was given May 13, 9 pounds of molasses, one-half pint of Black Leaf 40 and 51 ozs. of the soap flakes being used to 50 gallons. These two applications killed nearly all the psyllids, many of the insects being gummed to the leaves. There were less than one-tenth of one per cent of the number of galls observed the preceding season.

The hackberry bud gall, *Pachypsylla gemma* Riley, produces the numerous unsightly bud enlargements so characteristic of the hackberry. The insects winter in the galls as nymphs, the adults appearing much later than those of the nipple gall just discussed, namely about

June 10th. Trees sprayed June 11th with five gallons of molasses, three-fourths of a pint of Black Leaf 40 and 4 pounds of soap to 50 gallons of water gave a very fair degree of control. The foliage was well coated and many dead insects adhered to the leaves. Young bud galls of this species were not observed until early August at both Red Bank, N. J., and Stamford, Conn.

Knotty oak galls. There are several species producing irregular woody swellings, some smooth, some horned, upon various oaks and occasionally these deformities are so extremely abundant as to seriously affect the tree, killing branches and even the greater part of trees. An infestation of this character is a serious matter in the case of feature trees and consequently a study of several species has been commenced in the hopes of working out practical control measures.

The knotty oak gall of the red oak, *Andricus punctatus* Bass., a species which has been under the senior author's observation for some 30 years, is sometimes very common. It is comparatively easy to rear the adults from these galls and we were fortunate in securing oviposition in the buds and the subsequent development of small, blister-like leaf galls, usually on or near the veins. The insects are still within the galls at this date, November 19th, and consequently our knowledge of the life cycle is still incomplete.

The horned oak gall of the pin oak, *Andricus cornigerus* O. S., is another common species. We have succeeded, as in the case of the preceding, in obtaining what we believe to be galls of the alternate generation. These are small, whitish swellings along the midribs of developing leaves or beside the major veins. They are ovoid, whitish, sparsely covered with a fine pubescence and show mostly on the underside of the leaves, though one was evident upon the upper surface. The galls vary in length from 1.5 to 2.5 mm. with a width from .75 to 1 mm. and from one to eight may be found upon individual leaves. A number of adults issued from these leaf galls early in July and as yet we have not been able to trace the life history further. It is not even certain that these oviposited on the twigs.

There is a second horned oak gall, namely *Andricus clavigerus* Ashm. which is extremely abundant and injurious to willow oaks, a southern tree, and to date it has not been possible to do more than make a few observations on the abundance of the insect. We have not even obtained galls of the alternate generation.

The hickory leaf aphid, *Myzocallis fumipennellus* Fitch, has practically escaped notice in the North, at least as an economic species, although there is a record by T. L. Bissell of considerable injury by these insects in

1926 and 1927 to pecan in southern Georgia. (JOURNAL OF ECONOMIC ENTOMOLOGY 21:551–553, 1928.) Observations by the junior author led to the association in mid-August of orange spots upon hickory leaves with the minute black young of this aphid, and in order to demonstrate the connection with this condition, over 60 of these plant lice were caged upon a normal leaf and the development of the yellowish spots in some 10 days observed. These latter changed to brown within a week or ten days. Observations in the vicinity of Stamford, Conn. and also in eastern Massachusetts show this insect to be generally present and during 1929 it was undoubtedly responsible for a great deal of prematurely discolored and dead foliage. In severe infestations, this may occur the latter part of August and involve 95 to 100 per cent of the leaves. This means a decided check upon the growth of the tree.

There are two dangerous cambium borers which are constantly being brought to the attention of workers interested in shade trees. The bronze birch borer, *Agrilus anxius* Gory has destroyed thousands of birches in the northeastern United States and comparatively little is available as to satisfactory control measures. Our attention has been called within the last few months to a number of birches bearing evidence of serious earlier infestation by this insect and are, at the present time, in a very satisfactory condition. The change is attributed to the increased vitality resulting from feeding and the consequent stimulation of growth enabling the tree to overcome the attack of the borers. Last spring, a rather badly infested birch about one and a half inches in diameter was planted upon our experimental grounds and then fed liberally in order to demonstrate possibilities of helping trees in such a condition. The infestation on this tree was so marked that there was a question as to whether it would live through the season. It is a pleasure to state that the tree grew vigorously throughout the summer and is in a fair way to outgrow the earlier injury.

The two-lined chestnut borer, *Agrilus bilineatus* Weber, is a pernicious enemy of oaks, especially those in a somewhat weakened condition. There is very likely to be a concentration upon weakened trees in May or June, the first evidence being the dying of the top or even the entire tree in mid-summer. It is perhaps needless to add that conditions favorable for such injury are usually found in suburban areas, particularly where grading and building is in progress and in not a few cases feature trees are the victims of attack. Investigations during the past few weeks in a typical woodland show the two-lined chestnut borer to be rather generally present, especially on weakened trees or at the base of weakened or dying branches. The presumption is that enough of these

insects develop in the average woodland to provide a heavy infestation whenever trees present especially inviting conditions. The obvious deduction is that the removal of weak trees and sickly branches is an excellent preventive against infestations of this character and if for any reason, removal is not advisable, there is a distinct possibility, drawing upon experience with the related bronze birch borer, that judicious feeding may be the most effective preventive. Entomologists have recognized in a general way that the sick tree is likely to be attacked by insects and here is a case where the adoption of measures to restore vigor appears to be a practical means for control.

Filbert bud mite, *Eriophyes avellanae* Nal. This European species occurs on the European filberts and may blast 25 per cent of the buds. Infestation is indicated by the presence during the fall and winter of enlarged buds, nearly one-fourth of an inch in diameter. These never develop leaves. They shelter hoards of mites and are blasted the following spring. The mites were observed crawling somewhat generally upon the branches May 11 to 20, 1929, though none were found established in the new buds until August 26. Spraying with atomic sulfur, 5 pounds to 50 gallons, at the time the mites are crawling seems to be a fairly effective control measure.

There was an opportunity the past season to test the value of a calcium cyanide and castor oil combination recommended by Petch for borers in 1928. He applied a thick paste of the mixture to the base of apple trees infested by the round-headed apple tree borer, smearing the infested area with a small paint brush and obtaining a good control without injury to the tree. The method was used by us for the control of the linden borer, *Saperda vestita* Say, on recently set trees. A moderately thick paste was made and applied to areas indicating borer activity, a little pains being taken to cover the opening to the gallery. The results are apparently very satisfactory.

PARLATORIA OLEAE COLV., A PEST OF PRIVET IN MARYLAND

By H. S. McConnell, *Agri. Exp. Station, College Park, Maryland*

Abstract

Report of establishment of *Parlatoria oleae* Colv. in Maryland and preliminary notes on biology, food plants, natural enemies and control.

In the spring of 1927, Mr. F. C. Barklage, gardener for the Baltimore and Ohio Railroad, submitted some California privet twigs, collected in Baltimore, Maryland, to Dr. E. N. Cory, that were infested with a scale insect which proved to be *Parlatoria oleae* (Colv.).[1] According to Dr.

[1]Identified by Dr. Harold Morrison of the Bureau of Entomology.

Harold Morrison, this scale has been known at various times as *P. affinis* (Newst.) and *P. calianthina* (Berl. and Leon.), and there is still some difference in opinion among authorities in regard to its correct name. When this infestation was investigated practically all the Baltimore and Ohio Railroad's privet plantings in Baltimore were found to be infested. Since this first report, two additional infestations, each in a different part of the city have been found, one of which has been quite destructive.

No previous reference to the establishment of this insect in the United States has been found. However, it has been intercepted often by quarantine inspectors. Just how important this species may become as a pest of plants other than privet is a matter of conjecture. Present indications are that it will be a serious pest of privet, a plant that has been remarkably free of insect pests. Associated with *Parlatoria* on the Baltimore and Ohio plantings, a light infestation of cherry scale, *Aspidiotus forbesi* (Johns.), was found, which incidentally is a new host for cherry scale.

An effort was made to ascertain the source of the plants in the railroad company's hedges, but it was impossible to find the invoices. According to the gardener, the plantings were made about fifteen years ago, which indicates that this infestation is one of several years' standing.

Description of Scale and Its Injury to Privet. The female scales average 1.3 mm. long and .9 mm. wide, but vary from nearly circular to elongate; convex, dull white to dirty gray in color; exuviae large, covering about half of the scale; commonly yellowish brown to black in color. The female insect is slightly longer than wide, with head and caudal ends bluntly rounded. When full grown it is dark purple in color. Plate 6, figure A shows the pygidium. The male scale is about 1 mm. long; white, with yellowish exuviae.

Most of the injury to privet occurs on wood one year old or older. A few scales are found on new wood late in the season about buds and leaf petioles. The attack is most severe on the old canes where the scales overlap, and pile up in some cases two to four deep. Under these conditions the twigs have an ashy gray appearance. The plants that have heavy infestations make very little growth, often not exceeding two inches in length during the season and this growth is killed the following season. The result is that the tops of the plants become a thick net work of fine dead twigs. The ultimate result is that many of the plants die. See Plate 6, figure B.

Distribution and Host Plants.[2] From the information available it seems very probable that the Mediterranean region is the original home of this insect. It has been previously reported from Algiers, Austria, France, India, Italy, Morrocco, Palestine, Southern Russia, and Spain. Its host plants are too diverse to enumerate them all; more than forty are recorded. The more important hosts so far as the United States is concerned are, pear, peach, plum, lemon, orange, grape, cherry, ash, holly, locust, and oleander. In Europe, pear and olive are more severely injured than other hosts.

Summary of Life History. The winter is passed as a full grown or nearly full grown insect. With approach of warm weather, the full grown females begin to lay eggs. They are light purple in color when first layed, but become darker as the incubation period advances. The overwintering females lay an average of about 60 eggs each. In 1928 the first eggs were observed on May 3, and in 1929 on April 11. The incubation period varies from 15 to 30 days. There are two full generations each season and perhaps a partial third.

Natural Enemies. To date only two natural enemies of this insect have been observed. One hymenopterous parasite, *Aspidiotiphagus citrinus* (Craw.),[3] a species of cosmopolitan distribution, has been reared in small numbers. The other enemy observed is the larvae of an undetermined coccinellid beetle, which feeds on the scales.

Control. In experiments conducted so far, oil is the only insecticide that has been used against this scale. Lime-sulphur has been used in Europe, but under conditions prevailing in Baltimore is not as convenient as oil, on account of the proximity of hedges to houses. One application of 3% oil emulsion, applied before the leaves come out in the spring, gives promise where scales are not over-lapped or piled up. Examination of sprayed twigs, where there was no over-lapping of scales showed only one live scale to each 13 inches of twigs. On twigs where the scales were over-lapped or piled up, one application of 3% emulsion was less effective.

[2]The author is indebted to Dr. Harold Morrison of the Bureau of Entomology for much of the information on foreign distribution and host plants.

[3]Identified by Mr. A. B. Gahan of the Bureau of Entomology.

A—Pygidium of *Parlatoria oleae* Colv. x150.

B—Privet hedge injured by *Parlatoria oleae* Colv.

BACTERIAL WILT DISEASE

By F. MARTIN BROWN, *Avon, Conn.*

It is interesting to recall that among the earliest researches to link disease and micro-organisms we find Pasteur's work on the diseases of silk-worms. Today we know, comparatively, little more concerning the diseases of insects. When it is possible to control and spread these diseases, the task of economic entomology will in some respects be lightened. However to date, there are no practical and successful methods of disseminating bacterial insect diseases. Those diseases that do assist in pest control are natural and sporadic.

In 1926, the author started a series of experiments at the American Museum of Natural History's Station for the Study of Insects with a bacterial wilt disease.[1] The cultures used were from an infected larva of *Danaus archippus*, the common Monarch Butterfly, and were determined as a strain of *Staphylococcus flaccidifex* Glaser. The organism is a member of the *Staphylococcus pyogenes* group and quite capable of being a fatal and contagious pathogen for insects.

During the following spring, 1927, at Newport, Rhode Island, several rather unsuccessful attempts were made to introduce the disease into colonies of tent caterpillars by spraying the tents with dilutions of broth cultures of the organism. In some instances as many as ten per cent of the colony died of the disease, but apparently the virulence had been considerably attenuated by several months of culturing on synthetic media. However, there seemed to be sufficient success to warrant a future trial. Unfortunately, my stay the following summer at the Station for the Study of Insects was interrupted and no new cultures were collected. At the Nashville meeting that winter, Dr. R. C. Smith of the Experiment Station at Manhattan, Kansas, told me of a disease of *Eurymus eurytheme*, the alfalfa pest, that he had observed and promised to send me material. This was received during the early summer of 1928. With this, the old cultures of 1926 and several new strains, I set about a second series of experiments with the assistance of Mr. F. E. Watson of the American Museum staff and of one of my students, Richard Iversen.

The work consisted primarily of determining whether or not the organism *flaccidifex* was a general pathogen or whether each strain was restricted to a single species or family of insects. We soon found that apparently all lepidopterous larvae were equally affected by each strain.

[1]Brown, F. M. Description of New Bacteria Found in Insects. American Museum Novitates No. 251, February 21, 1927.

Strains from *D. archippus*, *P. turnus*, *P. rapae*, *E. eurytheme*, *P. huntera*, *C. promethea*, and *A. luna* were used in the experiment. In each case the gross clinical picture showed the larvae to be turgid and immobilized, blackened, and the internal organs to be disintegrated. The microscopic picture in all cases showed many lancet shaped pairs of gram positive cocci markedly resembling pneumococci. These conditions are practically identical with those found by Rief and by Glaser in their work fifteen or twenty years ago with the gipsy moth.

In the laboratory, using *Pyramais huntera* and *Callosamia promethea*, the disease proved to be highly successful both as to fatality and contagion. Field work, however, was again disappointing and only in colonies weakened by crowding and lack of food was any measure of success attained. At this time three methods of infection were used, with about equal success or lack of success; first, the early method of spraying; second, the surface infection of several individuals entering the nest; and third, injection of cultures into individual larvae and their release into the nests. The last method was perhaps the most successful but at the same time it is the least applicable.

To summarize, no real success has been met with in efforts to artificially infect healthy field colonies of the common tent caterpillar, *Malacosma americana*, with wilt disease caused by *Staphylococcus flaccidifex* of known pathogenic character. However, I am convinced that someone will find a successful method of using this organism or some other insect pathogen for the economic control of insect pests.

I wish here to acknowledge my indebtedness to Dr. F. E. Lutz of the American Museum of Natural History and to Dr. A. F. Burgess of the Gipsy Moth laboratory for their constant encouragement.

THE OCCURRENCE OF THE NOSE FLY, *CEPHENOMYIA*, IN THE DEER OF PENNSYLVANIA

By Dr. Norman H. Stewart, *Bucknell University*

(Withdrawn for publication elsewhere.)

SOME PHASES OF THE MEXICAN BEAN BEETLE CAMPAIGN

By Ernest N. Cory, P. D. Sanders, and W. T. Henerey,
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Abstract

A general account of the campaign against the Mexican bean beetle showing how all forces joined in preparing the growers to fight the Mexican bean beetle and how energetically and successfully the growers took hold of the proposition, together with information on spraying materials and practices and their costs.

During 1928 the Mexican bean beetle became established throughout Maryland and destroyed many bean fields. As a result bean growers, particularly the bean canners, became thoroughly aroused to the necessity of combating the pest during 1929. Maryland is a large grower of early string beans, and early and late (October) bush limas for market. The State ranks third in the canning of green beans and is well up in the list in the canning of lima beans. Therefore, with such large interests at stake and with the motivating force of destroyed crops in 1928, the problem of arousing interest was simplified.

A campaign of education was begun in the late summer of 1928 by the Department of Entomology, through the County Agricultural and Home Demonstration Agents. By means of exhibits at fairs and lectures, supplemented by circulars and information cards, the story of the beetle and its control was carried to the home gardener, the trucker and market gardener and to the canner and his associates. The Tri-State Packers' Association, The State Vegetable Growers Association, The Peninsula Horticultural Society, and the University Canners' School all served as agencies to receive and spread the gospel of control in 1929.

By conferences with Federal workers and officials of other states, an attempt was made to avoid as far as possible all debatable recommendations, and to make the directions as few and as concise as possible. One outstanding question, whether to dust or spray, had to be answered on the basis of individual conditions of terrain, water supply, and other factors. While spraying had given better results in all territories previously invaded, it was felt necessary to advocate dusting under certain conditions. Otherwise it was certain that many growers would have felt that control, in the hilly sections, was impracticable or impossible.

The number of materials recommended was cut down to magnesium arsenate for spraying and magnesium arsenate and lime or 20% copper sulphate, 20% calcium arsenate, and 60% hydrated lime for dusting. Pyrethrum sprays were advocated for any applications that were necessary on beans after the pods were formed as arsenicals were distinctly discouraged after pod formation on snap beans.

Emphasis was placed on applications as soon as beetles began to appear in considerable numbers in the fields with repetitions every 8 to 10 days depending upon the weather, rate of growth of the plants and the continuance of migration into the fields. Plowing down vines immediately after the last picking was urged and generally practiced.

Even though only four materials were recommended, the number and variety of the combinations put on the market was remarkable. As a general thing, canners and the largest truckers adhered to the recom-

mended materials. However, so numerous were the materials sold in the state, that it was found advisable to test twenty of the principal combinations for their effectiveness in control and safety on the foliage.

Materials tested to determine whether they would make the arsenicals less likely to injure the foliage resulted in showing advantage from the admixture of copper sulphate, litharge and zinc to calcium arsenate. Copper sulphate in all tests reduced the injury from arsenic, whether the combination was a dust or a spray. Magnesium arsenate used as a liquid spray is the most effective measure for commercial control where conditions permit the use of a power or large traction sprayer. Where dusting is advisable, the copper arsenic lime dusts should be used and it is probable that a 15–15–70 formula will be most satisfactory.

Early applications were necessary on all but the earliest market beans. Some fields were dusted as early as May 14. Emergence began in our cages at College Park on May 4 and continued to July 1 with the peak between June 1 and 8 though in other parts of the state the first adult was collected on March 30, the first eggs on April 6 and the first larva on April 27. An average of 15% emergence was recorded for 4,000 beetles put in the 4 cages. The first adult of the first generation emerged June 27.

Commercial dusting was begun in Western Maryland on May 29 and on the Eastern Shore the first spraying and dusting began May 27 to June 12 depending upon how far south the fields were located.

Cost and time figures were difficult to secure from commercial operations. Hand dusting required 2¼ hours per acre; four row dusters ½ hour per acre; and four row sprayers ¾ hour per acre. These averages varied with the size of the fields and the proximity of the water supply, though the latter item was offset in some operations by the use of water tanks hauled to the fields. The reduced time of spraying was one of the unlooked for developments. Fields as large as 80 acres were dusted twice with excellent results and plantings of 110 acres were sprayed twice with even better results at a lower acre cost. The average cost of dusting for 3 fields ranging from 1 to 7 acres, using the copper arsenic lime dust at 20 lbs. per acre, was $2.91. In another set of records, dusting 2 fields of 10 and 14 acres, the average cost was $1.04, using 14½ lbs. per acre. The average cost of spraying plantings ranging from 1 to 14 acres, using 3 lbs. of magnesium arsenate per 100 gallons, was $1.78 per acre.

The need for an efficient small sprayer appears to be partly satisfied by a two row sprayer and mopping machine that operates effectively at low

pressure and with about 1/3 the amount of liquid usually applied. This has been under test and observation in Maryland.

A combination of cool nights and drought during August cut down the second generation by reducing the egg deposition. Many late plantings were not treated and satisfactory crops were harvested. Likewise most of the extra early snap beans were not dusted or sprayed and good crops were picked, but the amount of injury developed amazingly toward the last and, if plowing had not been done promptly, all the later plantings would have been more difficult to protect.

Thorough preparation for combating the pest was universal; a vast amount of insecticides was sold; one company alone sold 96 traction or power dusters and sprayers and over 300 hand dusters; other companies sold more machines than the most sanguine would have dared to predict; the recommendations in the main were followed carefully; and the result in education and actual control exceeded the normal expectancy.

PLOWING AS AN AID IN MEXICAN BEAN BEETLE CONTROL

By P. J. Chapman and G. E. Gould, *Virginia Truck Experiment Station*

Abstract

Several tests show that plowing may be effective in destroying the Mexican bean beetle, especially the immature stages. Observations are included on the longevity and food habits of beetles unfed since emergence; observations which apply to survivors of plowing done while the population is in the pupal stage.

Possibly no advice on insect control is more freely given than that of clean culture, plowing under of infested hosts and related practices. For such oft-quoted recommendation there is a surprising dearth of experimental evidence to indicate the ways that these methods are truly of economic value to an individual or to a community. We suspect that the originators of many such statements feel justified in the strength of the common sense principle that "every little bit helps." Far from quarreling with such obvious logic, we take the position that before more than the usual emphasis is placed on these control methods an attempt should be made to measure their worth.

This type of problem is admittedly one about which it is difficult to obtain much precise information. We have reported (Va. Truck Exp. Sta. Bul. 65; 691, 1928) on our 1928 observations in this connection as they apply to the Mexican bean beetle. These were burial tests conducted in wooden frames under more or less controlled conditions. The present paper is a report of field trials of burying by means of plowing—with additional related observations.

Plowing Experiments. *Experiment 1.* A field of snap beans on the Whitehurst Farms, Norfolk, Va. was used in this first test. It had been abandoned after the first picking because of severe damage caused by the bean beetle. On August 9, 1929 the population was mostly in the pupal stage. On August 10, this field was plowed with an 8-inch walking plow. The use of a small plow was contrary to advice, but its use did give opportunity to observe what would result from this type of treatment. The soil was a sandy loam and at the time of plowing rather dry. On August 11, however, 1.25 inches of rain fell, which, according to our 1928 experiences should have created soil conditions unfavorable to insect escape. From the standpoint of clean plowing a poor job was done. The furrows "ran with the rows" and one could readily distinguish rows of uncovered plant tips everywhere in the field. Cheesecloth was put down over two representative areas to retain any stages which were able to gain the soil surface. The record is as follows:

Plat	No. Sq. Ft. Observed	No. Beetles Recovered 8/15	8/19	Total	Acre Estimate of No. Beetles Gained Surface
1	315	399	79	478	66,100
2	305	347	110	457	65,200
Total or Average	620	746	189	935	65,650

It was perfectly evident from walking through the field that a considerable number of insects had survived the plowing operation. On August 15, one could find beetles crawling about on the soil surface, but most of them were clustered on the uncovered tips of bean vines. The stiffer bean vines and weeds (most of the weeds bore a heavy population of pupae) prevented packing of the earth and consequently created avenues of escape for beetles emerging under ground. So successfully had the stems held up the earth in many cases that a beetle emerging below ground had simply to crawl up a stem to gain freedom. For the purpose of estimating the per cent killed by the plowing operation we placed the original population per acre at 1,200,000 individuals mostly pupae (based upon estimates in Experiment 3). Because of the unfavorable location of many pupae, possibly 25 per cent of this number would normally have succumbed to the hot weather[1] prevailing at this time, although several thousand pupae collected in this field actually showed a lower mortality. From these assumptions, however, we arrive at 7 per cent as the number reaching the soil surface alive.

The majority of the beetles seen on August 15 had disappeared by August 19, and since dead individuals were uncommonly found we concluded that most of the "plow-survivors" had flown to new fields.

[1]Howard and English. U. S. Dept. Ag. Bul. 1243, p. 28.

Experiment 2. The experimental plat was a small patch of snap beans on the Station grounds. The bean beetles present were principally pupae with a few larvae and adults. Soil a Norfolk loam. On August 13 the plat was plowed, and here too an 8-inch walking plow was used. We attempted to do a thorough job, but in spite of our best efforts an occasional plant top remained visible.

We covered 120 square feet with cheesecloth and three days later found three adults and 8 larvae on the surface—all dead. Seven days after plowing nine additional adults were discovered and these too were dead.

Experiment 3. A small planting of Fordhook lima beans was selected for this test. Bean beetle damage was pronounced, although there was enough bulky growth remaining to offer a problem in clean plowing. A census of the bean beetle stages present before plowing was made by examining plants from selected samples totaling 25 square feet. On an acre basis these would approximate the following:

Egg Masses	Larvae (Mostly Full-Grown)	Pupae and Prepupae	Adults
1500	200,000	335,000	65,000
Total All Forms			601,500

The soil, a Norfolk loam, was in excellent condition for plowing on August 15. In order to test several cultural methods the following procedure was followed. First the eastern half of the plat was gone over twice with a disk harrow which had been so set that the vines were thoroughly cut up and the soil pulverized. After this operation the entire plat was plowed. We used two fourteen-inch bottom plows which were drawn by a tractor. The plowing depth was about 8 inches. A rather good job resulted, although an occasional tip was visible in that part of the field where the vines had been turned under direct. Finally, a spike tooth harrow was used on the southern half of the plat. To avoid pulling out buried vines the teeth in this harrow had been set at such an angle that it functioned more as a drag. Cheesecloth was then stretched over each of the four areas to entrap surviving larvae and beetles. The following records were taken:

Area	Treatment	No. Sq. Ft. Observed	No. Insects Came to Surface			Acre Estimate of Insects Surviving as Adults	
			Larvae	Adults	Total	Number	Per cent
1	Plowed	136	35	22	57	7,046	1.17
2	Plowed and Harrowed	194	16	41	57	9,206	1.53
3	Disked and Plowed	136	0	0	0	0	0
4	Disked, Plowed and Harrowed	194	0	0	0	0	0

Behavior and Fate of Insects Surviving Plowing. When clean plowing has been done, the larvae which reach the surface have little chance to survive. Those at the field margins may, of course, crawl to food in another field if such is near enough at hand; we have abundant evidence of third or fourth instar larvae crawling 12 to 15 feet in search of food.

An appreciable mortality takes place even among beetles that have reached the soil surface. A plowed field offers little protection from the direct rays of the sun which, if of sufficient intensity, apparently results in deaths, especially among weakened individuals. Others, when transforming to beetles underground, and subsequently struggling to escape, may become so weakened or deformed that they are unable to fly to food and hence soon die. There appears to be, furthermore, a pronounced need for food after emergence before any prolonged flights are made. And if food is at too great a distance or if it is not soon found, still others may die. This brings up the question of how long beetles may live without having food after emergence. We have the following records.[2]

Date Emerged	No. Used	No. Dead Days After Emergence 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Average
August 26–27	100	0	4	4	3	—	27	16	38	10	1							
Mean Temp.		79	74	71	68	78	73	73	72	77	83							75
Oct. 25–26	100	0	1	—	8	15	12	31	20	8	3	0	0	0	0	1		
Mean Temp.		62	58	60	63	66	70	70	72	60	51							63
Oct. 28–29	123	0	2	1	13	4	3	16	11	17	7	9	8	8	28	4	2	
Mean Temp.		63	66	70	70	72	60	51	50	56	57	55	48	53	56	65	68	60

It is erroneous to assume, of course, that beetles would recover should food be supplied within a day or more of the time when death would take place. It is likewise erroneous to assume that in the event of survival, such beetles would continue life in a normal manner. These are problems which may be considered at a future time.

Newly emerged beetles which have been unable to find food in the immediate vicinity of the site where they transformed are responsible in part for rather unusual food records. These are the individuals which we have found feeding commonly on stems, flowers, and pods of beans when the leaves are unsuitable. Cowpeas, soy beans, and alfalfa are also readily attacked. On August 26, 1929, 464 marked beetles, which had had no food after emergence, were liberated 50 yards from a snap bean field, but only 6 to 8 feet from some soy beans. This soy bean field lay between the snap beans and where the beetles were liberated. Several days later we failed to locate a single beetle in the snap beans, although what appeared to be the entire lot was found at the edge of the soy

[2]Live beetles taken in plowing experiment No. 1 gave similar data.

bean field. These beetles were kept under observation for several weeks. No eggs were laid, that we could find, and it was not long before the insects disappeared. About September 9, however, a single marked beetle was found in the snap beans.

A similar lot of marked beetles was liberated 50 yards south of another snap bean field. The wind at the time of liberation and for several days following was from the northeast. No beetles of this lot could be located in the snap beans. Some 50 yards to the south of the liberation point, however, marked beetles were found on alfalfa and soy beans.

INFLUENCE OF WEEDS ON SURVIVAL. The presence of weeds in crops severely infested with bean beetle may influence the number of individuals reaching maturity in two ways. (1) Weeds, especially those with broad leaves, are commonly sought out as sites for pupation, even when infestations are only moderate. If, however, larvae destroy most of the bean leaves and weeds are not available, many will be forced to pupate in situations exposed to the direct rays of the sun. Pupae so located are likely to die should high temperatures prevail during the pupation period. (2) To a slight extent, a few species of weeds may serve as food to larvae in the absence of beans. At the Whitehurst Farms, Norfolk, Va., August 9, 1929 we found a number of black mustard (*Brassica nigra* (L.)) plants with leaves that had been skeletonized by larvae. And on November 1, 1929 a single larva was discovered feeding on shepherd's purse, *Capsella bursa-pastoris* (L.). In the Whitehurst field no feeding, as such, could be found on lamb's quarters, jimson weed, dock, ragweed, pigweed, smartweed, purslane and spurry, although all of these bore numbers of pupae. There is, therefore, this rather hypothetical possibility: some larvae in the absence of more desirable food may obtain enough sustenance from certain weeds to complete their growth.

DISCUSSION. The immediate plowing under of bean vines at the completion of harvest should be encouraged in areas where the bean beetle occurs. This practice may benefit either the individual directly, or may be a less tangible value as it improves the conditions of the community. Emphasis should be placed particularly on the importance of reducing the number of bean beetles entering hibernation. In this area semi-abandoned lima bean fields support large numbers of insects until late in the fall. The destruction of these and all "spent" bean vines as the hibernation period approaches should result in appreciable benefits.

Where growers plant a succession of snap bean crops, plowing under of the old vines may be of direct value to an individual in lessening damage to younger plantings. Under such intensive culture the practice

is already common to plow fields shortly after a crop is harvested in order that another kind of crop may be put in; the presence of the bean beetle should simply be an additional incentive to early and thorough plowing.

Snap beans such as the Bountiful variety mature so rapidly that only a single brood of bean beetles may mature on a given planting. One frequently finds the population predominantly in the pupal stage at the end of picking. If such fields are immediately and thoroughly plowed, few insects should survive. Lima beans, on the other hand, have a long growing and bearing period. In this locality three broods often complete their development on a single planting. A brood may mature before beans are ready to pick, and a grower would hardly plow under a field before it comes into bearing or shows promise of bearing later, unless bean beetle damage is extreme. Too often such lima bean fields remain the season through, unprofitable to the owner from the standpoint of production, yet serving the species in providing an abundance of individuals for hibernation.

We believe, in conclusion, that disking before plowing, at least under certain conditions is a distinct aid towards creating soil conditions unfavorable for bean beetle escape.

THE EUROPEAN CORN BORER WITH RESPECT TO SWEET CORN IN NEW YORK

By George E. R. Hervey, *Experiment Station, Geneva, N. Y.*

Abstract

Results are here given of two years experiments in the control of the corn borer. It appears that the infestation is somewhat lighter this season than in 1928 which is probably due to late planting and a poor stand of corn. Plowing as a means of disposing of corn refuse has given very satisfactory results in reducing the infestation. This is illustrated by the results of a two-year survey in the Eden Valley section where clean up measures are practiced. Experiments with insecticides indicate that this is a possible means of combating the insect. Calcium fluosilicate appears effective against the young larvae. White oil emulsion also offers promise when used with aresnate of lead. Various dusts have been tried but have not given an appreciable reduction in infestation.

Owing to the threatened invasion of the European corn borer to the sweet corn industry in New York State it was considered advisable to begin investigations into the nature of the injury and possible means of control of the pest. Accordingly in the fall of 1927 studies were undertaken with a view to attacking the problem from several angles, such as, determining the extent of the injury to sweet corn in New

York, life history and habits of the insect, the date of planting in relation to the rate of infestation, the value of plowing in the control of the insect and developing an efficient insecticide to be used against the caterpillars. The following notes are a summary of our results to date.

The situation in relation to the sweet corn industry in New York is somewhat better than it was in 1928. Some early plantings in the infested area along Lake Erie and Lake Ontario show a high infestation but later plantings apparently escaped with little injury. This seems to be also true of the infested area around Schenectady and in Albany County. Late planting and a poor stand of corn in many cases probably account for the lighter infestation. The corn grown for the canning factory showed only a light infestation in all infested areas this year. The Genesee Valley and Monroe County which produce considerable corn for the canning factory averaged less than 10 per cent. This is no doubt due to the fact that nearly all canning corn was not planted this season until the first week in June and in some cases later.

During the past two years we have been conducting a series of plowing experiments in the western part of the state to determine the mortality of the borers due to this operation. In addition to a number of cage experiments we have used a series of plats, 50 feet square, in which infested stalks have been buried at different depths. In order to determine the number of caterpillars that regain the surface of the soil after being buried traps were arranged around the edge of the plats. We have not been able to find any significant difference in the number of caterpillars recovered when buried at depths ranging from four to ten inches. The average emergence of caterpillars when buried in gravel soil in plats 50 feet square during late autumn is 32.56 per cent. The average emergence from plats of the same size when buried in the spring is 64.44 per cent. These plats were also covered with cheese cloth previous to the flight of the moths to determine whether any of the caterpillars were able to pupate in the soil and emerge as moths. The emergence of moths from the plats this season was less than 1 per cent. We did find, however, that if the plats were not cultivated at intervals after the infested material was plowed under the emergence of the moths was somewhat higher. In the course of the investigations it was considered advisable to determine the fate of the caterpillars which come to the surface after being buried. By means of various experiments and observations we have come to the conclusion that only a very few of these caterpillars are able to survive under ordinary field conditions unless adequate shelter in the nature of corn refuse or

other plant debris is present. The factor which seems to be chiefly responsible for the mortality of the caterpillars is exposure. From our observations it appears that they are able to move considerable distances in search of shelter and may live for several days before succumbing. We have also noted that birds, especially robins, pick up a great number in the spring of the year. Ants have also been noted destroying large numbers of them when free on the surface of the soil.

The value of community effort in reducing the infestation of this insect is well illustrated in the case of the Eden Valley section. This is a comparatively small market garden section in the infested area near Lake Erie in which there are about three hundred acres of sweet corn grown for the market. The farmers have for the past few years practiced a method of disposing of the corn stalks which has apparently worked out very satisfactorily. The stalks are cut as soon as the ears are picked and are then placed in the silo. The stubble is then disked thoroughly four or five times and the land is sown to rye. The rye is plowed under the following spring together with the pieces of corn refuse left on the surface. In view of the fact that these practices are in line with our experiments with plowing we considered that a survey of this area should show a noticeable reduction in larval population from year to year. Accordingly a survey of the corn borer situation was started in this section in 1928. The following are the averages for the years 1928 and 1929.

Year	Acres Examined	No. Ears Count.	% Infest.	No. Borers 100 Ears	No. Stalks Count.	% Infest.	No. Borers 100 Stalks
1928	45¾	2750	18.2	22.7	4550	23.5	53.4
1929	50½	3550	9.56	11.01	5100	11.92	23.42

A number of experiments have been conducted with a view to developing an efficient insecticide to be directed against the newly hatched caterpillars. Several materials have been tried and some of them have effected a considerable reduction in larval population while others had to be discarded owing to severe injury to the corn plant or ineffectiveness toward the corn borer caterpillars. Calcium fluosilicate, which was tried as a spray by the Bureau of Entomology last season, appears to offer the most promise at the present time. It has however been noticed that there is some injury to the corn plant following applications of this material. White oil emulsion also looks promising but is apparently more effective when combined with arsenate of lead. This oil emulsion when used at 3 per cent gave a high rate of mortality against the egg masses but at strengths less than this the effectiveness was varied. Arsenate of lead when used with fish oil as a sticker also gave

a noticeable reduction. Various materials, such as, arsenate of lead and hydrated lime, tobacco dust, lime nicotine dust, copper lime dust, and sodium fluosilicate when used in the form of a dust gave little or no reduction when compared with the checks.

THE PLUM CURCULIO OUTBREAK IN THE CHARLOTTESVILLE-CROZET SECTION OF VIRGINIA IN 1929

By L. R. Cagle, *Assistant Entomologist, Virginia Agricultural Experiment Station*

Abstract

An attempt is made to explain the heavy losses from curculio in the Charlottesville-Crozet section. It is believed that the important factors were omission of the petal-fall spray, lack of thorough cultivation, and heavy rainfall in the early season.

There was a general outbreak of the plum curculio in peaches throughout Virginia in 1929. This outbreak was coincident with a somewhat heavier infestation of oriental fruit moth than normal in the older infested orchards and with the occurrence of this insect in some new sections of the State. Information regarding the oriental fruit moth had been broadcast, and, when a heavy infestation of worms was noticed in the Crozet section, it was thought to be due to this insect. By examination of the culled fruit, however, it was found that approximately three-fourths of the loss was due to plum curculio.

No systematic surveys were made to determine the curculio infestation in peach orchards over the State. From information available it is believed that the loss to Elbertas did not exceed 5 per cent in some sections, whereas, in the Crozet section, it ranged from approximately 5 per cent to 50 per cent, most orchards averaging between 20 and 30 per cent. The oriental fruit moth infestation of the same variety ranged from less than 5 per cent to 45 per cent. An inquiry was made to determine, if possible, the cause of the heavy loss from the curculio in the Crozet section.

Orchards were visited in the vicinity of Crozet and at Timberville where worms were comparatively few. In the former section a slight advantage was found in favor of liquid over dust but it was plain that the use of dusts was not responsible for the outbreak since losses were also heavy in orchards that had used liquid each year. In the Timberville section both liquid and dust were used apparently with good results. Many of the orchards in these sections are located on steep rocky slopes, which make cultivation difficult. Most growers, however, cultivated early in the season but few, if any, have practiced regular and thorough cultivations throughout the period when recommended for

the curculio. All orchards visited contained both apples and peaches. In some they were interplanted. Observations were made in two orchards in the Roanoke section in which studies have been made on the oriental fruit moth since 1926. In these orchards dust has been used for several seasons and regular cultivations have been given from early spring to midseason for many years.

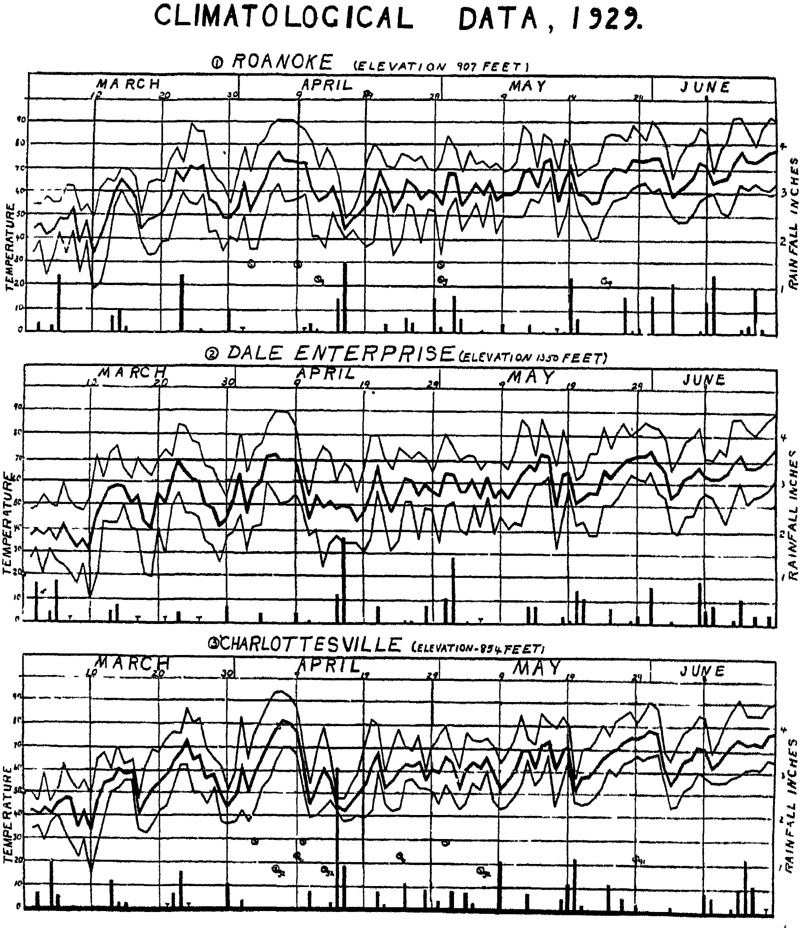

FIG.—17.

Figure 17 is a chart giving the climatological data for the three sections from March 1 to June 18. It will be seen that there was an extremely warm spell between March 20 and 30 and during the first half of April. There was also a comparatively warm spell around

March 15. It will be noted that at no time after March 12 did the temperature at Roanoke and Charlottesville fall below 32°F. while at Dale Enterprise, which is in the Timberville section, the temperature ran several degrees lower, dropping to 19°F. on March 19, to 25°F. on March 29, to 23°F. on April 13, and to 32°F. as late as May 17.

At Charlottesville and Roanoke, the blooming period of the peaches came during the last week of March. Complete data on this point and on the dates that sprays were applied were not obtained in the Timberville area. It is apparent, however, that the lower temperature there delayed the development of the trees so that the blooming period came during the hot spell in April instead of March. Quaintance and Jenne (1) found that adults leave hibernation when the mean temperature remains between 55° and 60°F. for a few days. Adults, therefore, probably left hibernation in small numbers around March 13, and in large numbers from March 22 to 26, so that during the extremely hot spell of the first ten days of April, they were in the orchards feeding and ovipositing in large numbers. This probably accounts for the heavy infestation of curculios noted in a number of orchards over the State in the early season.

Virginia spray recommendations call for the application of poison (1) at petal-fall, (2) seven days later, and (3) three weeks later. The tendency in all sections has been to omit the petal-fall spray. In the Roanoke section the first poison was applied at shuck-fall. In the Charlottesville-Crozet section, the general custom has been to make the first application just as the shucks break, the second about ten days later, and the third about three weeks later. At Timberville, some followed the spray recommendations, while others omitted the petal-fall spray. Snapp (2) states that the application of poison when 75 per cent of the petals had fallen materially reduced the infestation of small peaches in early spring. The omission of this spray has probably played an important part in the outbreak in this State during the past season, since the infestation of small peaches which drop each year has probably served to carry over the infestation from year to year.

The dates that poisons should have been applied according to Virginia recommendations are indicated on the chart by (S). The dates that they were actually applied by growers from whom records were obtained are indicated by (S)g. It will be noted that sprays applied on the dates recommended for Roanoke and Charlottesville would have furnished good coverage during the hot spell immediately following petal-fall and since there was very little rainfall during this period, a good kill should have been obtained with a consequent reduction in

wormy fruit later in both sections. The third application coming during a cool rainy spell would probably have had little effect in reducing the infestation. It is also seen that sprays applied by growers on the dates indicated by (S)g in both sections afforded very little protection during the past season. The first applications came at the end of the hot spell following petal-fall and were followed by heavy rains. In the Roanoke section, 2.16 inches of rain fell on the third and fourth days after this application. On the same dates, 4.07 inches of rain fell at Charlottesville. The second applications were probably made after the nurculios had ceased feeding on peaches. Quaintance and Jenne (1) found that the adults fed very little from the time the pits began hardening until the ripening period.

The above sprays applied by growers, no doubt, were equally ineffective in both sections. The orchard representing the Charlottesville section suffered a heavy loss from worms. This orchard is believed to be a fair representative of the section as a whole, both as to loss and as to spray practices. The orchard representing the Roanoke section, had a very light infestation of curculios except in the vicinity of a woodland. Observations in the early season in connection with studies on the oriental fruit moth showed a light infestation at that time in that part of the orchard away from the woodland. The writer, therefore, attributes this lack of worms to the thoroughness with which this portion has been cultivated in the past. That portion next to the woodland was on a rocky slope which has made cultivation difficult. This condition supplemented by the good hibernation quarters has probably caused an accumulation of insects which accounts for the infestation the past season.

One grower in the Piedmont near Crozet had practiced applying sprays according to the Virginia recommendations. The dates of the application indicated by $(S)g_2$ were a few days later than in the Crozet section proper because of the greater elevation of the orchard. The first application of poison being made at petal-fall and before the peak of the hot spell was reached, no doubt, gave a good kill of adults. The other sprays, however, were followed by heavy rains and were probably of little value. The application of poison at petal-fall each year has probably held the early infestation down so that the past season was begun with a small number of insects. This orchard was the only orchard visited in the section in which the owner did not report heavy losses. It was also the only orchard visited in which the petal-fall spray had been applied regularly each year.

Complete data were not obtained in the Timberville area. See 2 Figure 17 for climatological data. It is plain that the sprays were delayed considerably because of the much lower temperatures prevailing there. One grower had records showing that he was spraying on April 19. Other growers reported that poison sprays were applied during the latter part of April and in May. By examining 2 Figure 17 of the chart, it will be seen that the spray applied around April 19 came after the heavy rains of April 15 and 16 and was followed by a period of a week to ten days with comparatively little rainfall. The hot weather in early April, no doubt, brought out the adults in large numbers, so that this spray probably killed many of them, consequently reducing the infestation at picking time. It will be noted that the rainfall during the latter part of April and May with the exception of the heavy rains on May 1 and 2, was much less than in the Crozet section, and sprays applied during this time, no doubt, were more effective in reducing the number of curculios to infest peaches at picking.

Conclusions

1. The outbreak in the Charlottesville-Crozet section was not due to a second brood of curculio.

2. The practice of omitting the petal-fall spray in the past has permitted an infestation of peaches which drop early each season, although worminess of fruit at picking was prevented under normal conditions by the killing of the overwintered adults by later sprays.

3. Heavy rainfall after sprays were applied rendered sprays ineffective during the past season and allowed overwintered adults to live until the picking season.

4. Cool rainy weather from April 12 to May 20 probably caused egg deposition to be delayed so that a greater percentage of the eggs were not deposited until the ripening period of the fruit.

5. The importance of supplementing spraying with regular and thorough cultivations in early season was emphasized.

6. The apparently heavy infestation in early season was probably due to the fact that the abnormally high temperature during the blooming period brought the adults out of hibernation at that time so that they were in the orchards in multitudes when the peaches were large enough to furnish places for egg deposition.

7. By consistently following the practice of applying a petal-fall spray, a shuck-fall spray, and a three-weeks spray and supplementing this by thorough cultivations, another such outbreak may be prevented.

LITERATURE CITED

1. QUAINTANCE, A. L., and JENNE, E. L. 1912. The Plum Curculio. U. S. D. A. Bur. Ent. Bul. 103.
2. SNAPP, OLIVER I., ALDEN, C. H., ROBERTS, JOHN W., DUNEGAN, JOHN C., and PRESSLEY, J. H. 1927. Experiments on the Control of the Plum Curculio, Brown Rot, and Scab, Attacking the Peach in Georgia. U. S. D. A. Bul. 1482.

A PROPOSED BASIC DEFINITION FOR COMMERCIAL CONTROL

By V. I. SAFRO, *West Nyack, N. Y.*

ABSTRACT

Commercial control is the measure of protection from insect attack that yields the maximum net return at minimum expense.

Several years ago in Southern California, a citrus fumigating concern attempted the experiment of guaranteeing commercial control of citrus scales. The main results of the experiment were a number of more or less violent controversies—some of them still unsettled—as to what constituted commercial control. A number of entomologists endeavored to contribute some light upon the problem by making many detail records of the results of control operations, but no definite conclusions followed. No one knew what constituted commercial control. Tentative agreements among those interested, that a certain percentage kill as recorded by a certain method of observation and calculation constituted commercial control, still did not solve the basic problem. This experience has in greater or less degree been met with by most economic entomologists.

In his experimental work the economic entomologist endeavors to obtain at a reasonable cost a control as nearly perfect as the nature of the pest and the difficulty of repressive measures permits. In many cases the 100% experimental control of insect pests is obtained with a reasonable degree of care and thoroughness in the control operations. The economic entomologist does not assume that the grower, under his field and labor conditions will obtain a similar 100% control, though it is true that occasionally one does hear of such reports.

The usual procedure has been for the entomologist to report to growers those measures that under experimental conditions have given the maximum control, and then to indicate that such measures reasonably followed, should result in "Commercial Control." The grower is given to understand that he should be satisfied with this "Commercial Control" and not consider his operations a failure or the recommendations faulty merely because he has not obtained complete extermination of the pests.

Lack of accuracy in the meaning of the term has led to many disagreements as to efficiency of various measures for minimizing the losses caused by insect pests. Need of a more definite understanding has resulted too freuently in more or less arbitrary acknowledgment that anything above about 95% control—but short of 100%—was "Commercial." In the case of certain pests where numbers are very large and where field operations for perfect control difficult, the commercial control quite possibly may be more than even 99%. And conversely, where numbers of the pests are few, commercial control may be as low as 80% or, in still other cases, even less. Percentage kill may be used as a measure of commercial control in specific cases—but logically only after the establishment of an accepted definition for the term.

The following definition is herewith proposed: *Commercial control is the measure of protection from insect attack that yields the maximum net return at minimum expense for the control operation.*

The term "Minimum expense" includes material, labor, and what is fully as important, convenience, personal preference and availability. It is used to differentiate commercial control as here defined from that measure of control obtained by greater expenditures without a proportionate increase in the net value returned. The proposed definition contemplates that it is possible to increase control expenditures at a net loss for the operations concerned—even though a higher percentage kill is obtained. Each operation, in so far as it can be differentiated from prior and subsequent operations, is expected to return a profit to the grower. It is evident, therefore, that such higher percentage actual control obtained at a greater cost may not be as good commercial control as a lower percentage control at the minimum cost as specified in the definition.

A hypothetical case may be used as an illustration. Assuming that it is possible to obtain a 95% control of a certain pest, and that many growers do obtain it, an economic investigation may reveal that the last 5% control has been a loss to the grower. In this case, 90% will have represented the commercial control.

This definition is proposed in an endeavor to lead finally to an accurate workable understanding of the term on the basis of which specific economic studies can be made of commercial control operations. It may be protested that one cannot tell whether a certain measure of control has been commercial until the crop has been sold. As a matter of fact, the principle should hold without regard to the actual price received. The most dollars return means the most dollars return,

whether the selling price was $1.00 per barrel or $10.00 per barrel.

But, it may be objected, how does the definition apply if the crop turns out to be a loss? The definition would still hold inasmuch as commercial control would thereby contemplate the least net loss and in that respect would show a corresponding profit upon the specific control operations. In a case of this kind, had the measures representing commercial control been omitted, the net loss would have been still greater—and, as a matter of fact, in many actual cases it has worked out that the ultimate object of control measures has turned out to be fully as much a reduction of losses as a definite increase in gain. In a paper published about twelve years ago[1] the writer indicated that the cost of control measures may even exceed the returns from the crop and still be necessary.

"What," it may be asked, "is the status of the definition in cases where an anticipated insect outbreak does not take place?" Such situations occur very frequently—much to the distress of the entomologist who is conducting a demonstration test to prove the soundness of his recommendations. However, failure of the outbreak to occur is, in this respect, in the same category with drouths, excessively hot and dry winds, frosts, market failure, and other unforeseen contingencies. The normal expectations should govern the procedure to be followed. The proposed definition is not affected. If the normal expectations do not materialize it does not in any way affect the soundness of the procedures—though commercial control would then be as difficult to demonstrate as the benefit of any agricultural procedure if the crop is ruined by flood or frost.

It may further be protested that many insect-control operations are performed when no tangible returns are expected, such as on lawns, golf greens, flowering ornamentals, shade trees or fruit trees not in bearing. In such cases, though it may be difficult to present specific figures to prove the point, the proposed basic definition would still apply. The term "net return" may be in dollars, in potential value of the non-bearing trees, in pleasure obtained from ornamentals, in health from exercise or comfort from shade. In any event, the owner determines the value to him and commercial control to him is that control for which he considers the expenditures justifiably incurred.

[1] "When Does the Cost of Spraying Truck Crops become Prohibitive." Jour. Ec. Ent. Vol. 10 No. 6 Dec. 1917.

Thursday Afternoon, November 21, 1929

FURTHER STUDIES ON THE PROBLEM OF REDUCING THE NICOTINE UNIT CHARGE OF NICOTINE[1]

By ROBERT S. FILMER, B.S., *Research Assistant, Rutgers University, 1929–1930*

ABSTRACT

Results of laboratory and field tests show that unit charge of nicotine toxic to aphis is reduced to 1–4800 actual nicotine when ½ per cent (0.5 per cent) sodium oleate is used in spray mixture.

Mr. E. R. McGovran,[2] working with sodium oleate and nicotine during the summer of 1928, obtained high percentage kill of *Aphis pomi* and *Brevicoryne brassicae*, when one-half of one per cent, (0.5%), sodium oleate was used with high dilutions of nicotine.

As these experiments were carried out in the late summer when the vitality of the aphids used, might have been lowered, it seemed advisable to check his results with aphids obtainable early in the summer.

PROCEDURE. The following experiments were carried out in the laboratory at New Brunswick and in the field at Dayton, N. J., during May and June 1929 on *Aphis spiracolae*, *Myzus cerasi*, *Aphis rumicis*, *Aphis pomi* and *Aphis sorbi*. In view of McGovran's experiments the strength of sodium oleate has been kept constant, at one-half of one per cent, (dry bases by weight), throughout the experiments. Nicotine, as "Black Leaf 50," has been used throughout the experiments. All nicotine concentrations have been expressed in terms of actual nicotine.

The laboratory testing of aphids was carried out by a method similar to McGovran's. The aphis were brought into the laboratory on infested twigs or leaves which were placed in bottles of water to prevent wilting. The infested twigs were sprayed until all surfaces were thoroughly wetted and all excess spray material was shaken off. The jars containing twigs were placed on strips of paper containing "tree tanglefoot" barriers, which were so placed that any aphids dropping from the twigs fell inside the barriers. Counts were made 24 hours after spraying and the per cent kill determined. In counting, all aphids that were able to make any movement whatsoever and those which had crawled into the tanglefoot barriers were counted as alive.

LABORATORY TEST. The first purpose of these experiments was to check any possibility of the high percentage kill obtained by McGovran as due to lowered vitality of late summer aphids.

McGovran obtained the following results in late summer of 1928 with *Aphis pomi* and *Brevicoryne brassicae*.

[1]Paper of the Journal Series, New Jersey Agricultural Experiment Station, Department of Entomology.

[2]McGovran, E. R., N. Y. Entomological Society, V. — No. — pp. —.

APHIS—*Brevicoryne brassicae*

Material	No. Aphids	% Kill
½% sodium oleate	509	94.7
Aphis pomi		
½% sodium oleate	155	96.0
½% sodium oleate+1–10,000 Nicofume	980	87.6
½% sodium oleate+1–20,000 Nicofume	260	99.5

The following results were obtained in the laboratory during May, 1929, with *Aphis spiracolae*, *Aphis rumicis*, *Myzus cerasi* and *Aphis sorbi*.

AVERAGES OF TABLES, TABLE 1

Aphis Spiracolae

Material Used	No. Aphids	% Kill
½% sodium oleate	7232	88.3
½% sodium oleate+nicotine 1–25,000	7949	95.5
½% sodium oleate+nicotine 1–20,000	3508	97.0
½% sodium oleate+nicotine 1–15,000	2945	97.5
½% sodium oleate+nicotine 1–10,000	550	98.5
½% sodium oleate+nicotine 1–5,000	539	100.0
Aphis rumicis		
½% sodium oleate	1246	87.5
½% sodium oleate+nicotine 1–10,000	878	98.8
Myzus cerasi		
½% sodium oleate	1608	58.0
½% sodium oleate+nicotine 1–25,000	1431	77.0
½% sodium oleate+nicotine 1–5,000	991	98.0
Aphis sorbi		
½% sodium oleate	1728	87.0
½% sodium oleate+nicotine 1–5,000	1735	98.8

These results (Table 1) for ½% sodium oleate are slightly lower than those obtained by McGovran, but both sets of experiments show that high dilutions of nicotine when used with ½% sodium oleate give a high percentage kill of aphids.

These experiments are not directly comparable with McGovran's results as he used dilutions of 1–10,000 and 1–20,000 Nicofume which contains approximately 40% free nicotine. On the basis of actual nicotine these dilutions would be 1 to 25,000 and 1 to 50,000 nicotine. That there may be a gradual lowering of the vitality of aphids as their life cycle proceeds, seems to be shown in tests with *Aphis spiracola*. Test made on May 6th showed a somewhat lower per cent kill than aphids tested the latter part of the month with the same material.

FIELD TESTS. The purpose of these experiments was to control *Aphis pomi* and *Aphis sorbi* under field conditions. A series of experiments were carried out by spraying branches of apple trees heavily infested with *Aphis sorbi* and *Aphis pomi*. In this experiment ½% sodium oleate with nicotine at the following concentrations was used,

1–10,000, 1–5,000, 1–2,500. The trees sprayed had a heavy coating of lead arsenate and sulphur, frequent observations were made to determine the amount of control and to detect any leaf injury which might occur.

The results of these tests showed that very good control could be obtained in the field by using actual nicotine at 1 to 5000 or "Black Leaf 50" at 1 to 2500. At no time during the experiment was any foliage injury noticeable.

The orchard block tests were carried out in a commercial orchard at Dayton, N. J., where power driven spray machinery was used. In these experiments commercial potassium oleate replaced sodium oleate which was not readily available. The commercial potassium oleate used contained approximately 40% water, was readily soluble in water if allowed to stand for a few hours. Nicotine as "Black Leaf 50" was used, with all concentrations expressed in terms of actual nicotine. Blocks of trees were sprayed and kept under observation for several days. The blocks selected contained about 40 nine year old apple trees, which were sprayed with various concentrations of potassium oleate and "Black Leaf 50". Heavily infested branches were tagged after spraying and frequent observations made to determine the degree of control obtained. Control was considered *good* when all aphids appeared to be dead 24 hours after spraying and when there was no reinfestation due to reproduction after several days. *Fair* control denoted a high per cent kill but partial reinfestation due to reproduction after several days.

In all cases where branches were tagged for observation care was taken to see that aphids had been thoroughly wetted.

The spray was applied with spray rod, spray gun and Bean cluster in order to check any variations in wetting ability of the spray due to mode of application.

CONCENTRATIONS OF POTASSIUM OLEATE AND "BLACK LEAF 50"
USED PER 100 GALLONS SPRAY MIXTURE

Potassium Oleate	Black Leaf 50	Control
4 lbs.	1/3 pints	N.G.
5 lbs.	1/3 pints	Fair
5 lbs.	2/3 pints	Good
6 lbs.	1/3 pints	Good
6 lbs.	2/3 pints	Good

Note—Potassium oleate—approximately 40% H_2O.

These experiments showed that 4 lbs. and 5 lbs. of the commercial soap plus 1/3 pint of "Black Leaf 50" to 100 gallons of spray did not give complete control. It was observed that this concentration, while

toxic to the smaller aphids was not effective against the stem mothers, consequently a few days after spraying no check in the infestation was noticeable.

Five pounds of soap and 2/3 pints of nicotine gave fair control, was more effective as it proved toxic to some of the stem mothers.

Six pounds of soap and 1/3 pint of "Black Leaf 50" gave excellent results, killing all aphids that were wetted. This concentration was noted to give better spreading especially in cases where the rosy aphid had curled the leaves.

Six pounds of soap and 2/3 pints of "Black Leaf 50" also gave excellent control but as the cost of this concentration was higher and the degree of control comparable to six pounds and 1/3 pint of nicotine the latter concentration was selected to spray remainder of orchard. Where six pounds of soap was used in the spray mixture, no difference was noticed due to mode of application. However when soap was reduced to five pounds much better wetting was obtained with Bean cluster or spray gun. Where the leaves were badly curled by rosy aphid much better wetting was secured with Bean cluster or spray gun.

In all about 4000 gallons of spray was applied to foliage that had a rather heavy coating of lead arsenate and sulphur. At the close of the experiment three weeks after application of the spray there had been no foliage injury observed.

An experiment to test for any toxicity of sodium or potassium oleate to foliage of peach or apple was carried on in the college orchard at New Brunswick during the past summer.

Concentrations of .5% (½%) sodium and potassium oleate made up to various hydrogen ion concentrations with acetic acid and NaOH were sprayed on peach and apple foliage at weekly intervals over a period of two months. The hydrogen ion concentrations were varied from pH 4.0 to pH 8.0. At all concentrations tested no foliage injury was noticeable during the course of the experiment.

Summary

Aphis spiracolae, *Aphis rumicis*, *Aphis sorbi*, and *Myzus cerasi* were controlled in laboratory with one-half of one per cent sodium oleate plus 1–5000 actual nicotine.

In orchard tests *Aphis pomi* and *Aphis sorbi* were controlled with 6 pounds commercial potassium oleate (40% H_2O) plus 1/3 of a pint of "Black Leaf 50" per 100 gallons. This concentration is equivalent to ½% soap plus actual nicotine 1–4800.

In the orchard experiments where trees were sprayed while a fairly heavy coating of lead arsenate and sulphur was present on the foliage, no foliage injury was noticeable three weeks after application of the spray.

The laboratory experiments checked in a general way McGovran's work of 1928, in that it was shown, that low concentrations of nicotine when used with ½% sodium or potassium oleate was toxic to aphids.

Experiments showed that repeated sprays of sodium and potassium oleate were not toxic to foliage.

RESULTS FROM THE USE OF NICOTINE IN THE CONTROL OF SUCKING INSECTS ON POTATOES ON LONG ISLAND

By H. C. HUCKETT

ABSTRACT

This paper discusses in brief the efficacy of the average sprayer and duster under local conditions in combating aphids and leafhoppers with nicotine mixtures, as indicated by reduction in aphid population, condition of foliage with reference to hopperburn, and yield of tubers.

Within recent years aphids[1] and leafhoppers[2] have become a serious menace to the growth and production of potatoes on Long Island. The two pests are firmly established wherever potatoes are grown and appear each year in greater or less numbers according to the peculiarities of the season. There are about 40,000 acres of potatoes raised annually of which it is estimated that less than 10 per cent receives any specific treatment for sucking insects other than bordeaux mixture, and that at least 60 per cent, or 24,000 acres, are left as unrestricted breeding and feeding areas for these insects. The importance of the problem is increased by the fact that this area is not scattered but is centralised around a few well defined locations and further that fully 95 per cent of such land has raised potatoes continuously for the past 10 to 40 years.

Reliance has been placed in the past on spraying the foliage with bordeaux mixture as a protection against hopperburn, but not with altogether satisfactory results in recent years because the means and methods employed have gradually become inadequate to meet the requirements of larger potato fields and a greater intensity of insect migrations through increased population.

As with many other farm problems of a similar nature, it is difficult to see how any improvement in insecticides can be of value to the indi-

[1]*Illinoia solanifolii* Ashmead, *Myzus persicae* Sulz.
[2]*Empoasca fabae* Harris.

vidual until there is more spraying or dusting done by the community and with equipment of greater capacity; nevertheless, there is a demand for information relative to the efficiency of nicotine sprays and dusts, as applied, in checking the development of aphids and leafhoppers under local conditions together with the effect of such operations on the yield of tubers.

Aphids usually develop into threatening numbers shortly after the Green Mountain variety of potato has come into full bloom, a period during early July about 2½ to 3 months after planting. The early variety, Irish Cobler, escapes to a great extent the effects of aphid and leafhopper injury because of its earlier maturity during July, and hence the results of experiments with the late variety, which matures during August, are only presented. Hopperburn appears usually during mid-July for the first time. The combined attack of these two insects during this month is sufficient to cause, in the majority of seasons, the destruction of much foliage by the first week in August where spraying has been carried on, and two weeks earlier where spraying has been discontinued. Under the best of conditions the premature killing of the foliage takes place three weeks before the normal time for its occurrence.

TREATMENT. The nicotine spray[3] was applied by means of a 6-row traction sprayer fitted with 2 nozzles per row. The nozzles were placed to cover the "heart" of each row, being directed forwards and downwards at a level with the top of the plants. In addition a half inch pipe was attached to the sprayer at a distance of two feet in front of the nozzles to brush the vines over. Such a rig served to prevent vine growth from interfering with the spread of the spray from the nozzles before reaching the foliage, and to aid in turning the foliage into such a position as to permit the spray to gain contact with the under-surface of the leaves. Pressure was maintained at about 200 pounds per square inch, and the mixture was applied at the rate of 80 to 90 gallons per acre per application. The nicotine dust[4] was applied by means of a 4-row self-mixing duster with distributors directed backwards in a horizontal plane to the ground at a level of about 2 feet. A canvas, 25 feet in length, was attached to the boom, and allowed to drag over the vines. In dusting care was taken to choose favourable conditions for operation. The mixture was applied at the average rate of 50 pounds per acre per application. The treatments with nicotine dust were made as an alternative or substitute application for the normal copper-lime spray or dust applications.

[3]40 per cent solution of nicotine sulfate, 1 pint Bordeaux mixture, 100 gallons.

[4]40 per cent solution of nicotine sulfate, 3 pints; dolomite, 10 pounds; hydrated lime, 50 pounds.

TABLE 1. PERCENTAGE INCREASE OR REDUCTION IN THE RELATIVE NUMBER OF APHIDS ON POTATOES FOLLOWING VARIOUS TREATMENTS.

Treatment	Series I 1926	Series I 1927 Applications		Series I 1929 Applications		Series I 1928	Series II 1927 Applications		Series II 1929 Applications		Series II 1928
	1	1st	2nd	1st	2nd	1	1st	2nd	1st	2nd	1
Sprayed Plots											
Bordeaux mixture (4.6.50)	+55.4	—24.8	+170.7	— 19.5	—32.8	+31.1	—15.7	+529.5	—31.6	+ 84.0	—40.6
Bordeaux mixture-nicotine spray	—31.6	—15.5	+115.2	— 37.5	—19.8	—61.9	—22.4	+209.9	—32.1	— 27.2	+45.0
Nicotine dust	—52.5	—46.4	— 83.3	— 71.6	—76.3	—85.1	—65.6	+ 1.6	—69.6	— 43.8	—13.1
Check											
None	—31.9	—32.3	+583.1	+ 52.1	—13.3	—52.7	—7.7	+201.6	+61.5	— 5.4	—56.7
Dusted Plots											
Copper-lime (20.80)	+52.8	—12.8	+236.2	+161.0	—25.6	—18.0	— 3.5	+229.0	+15.1	+111.2	+72.6
Nicotine dust	—58.0	—80.3	+143.2	+ 28.8	—61.7	—59.1	— 8.1	— 11.9	—88.8	— 34.2	—20.8

SEASONAL CONDITIONS. A synopsis of the conditions as they occurred during the growing seasons of 1926 and 1929 in their relation to the experimental plots follows.

Year	Effect of Weather on Plant Growth	Number of Applications	Period of Treatment (Inclusive)	Number of Nicotine Applications	Most Harmful Pests and Diseases to Foliage
1926	favorable	5	6/25–8/4	2	leafhoppers flea beetles (2nd brood)
1927	favorable	7	6/17–8/6	2	leafhoppers flea beetles (2nd brood) aphids
1928	favorable	9	6/21–8/16	1	late blight
1929	unfavorable	9	6/6–7/30	2	aphids, leafhoppers

RESULTS

The results of the various treatments were recorded on three occasions, (1) immediately following each special application for aphids to determine the effect of the various treatments on aphid infestation, (2) at the close of the period of applications to compare the condition of the foliage in the various plots, (3) at digging to compare the yield of tubers.

The percentage increase or reduction in the number of aphids on the foliage in the various plots following special treatments during early July is given in Table 1.

According to the data given in Table 1 it will be seen that there was a marked variation in results except in the cases of nicotine dust treatment. The consistency and superiority of nicotine treatment in the dust form is all the more evident when comparisons are made between the respective treatments in the sprayed and dusted parts of the field. It is felt that the inferior results obtained in spraying with nicotine were in a large measure due to the inadequacy of the sprayer as rigged and to the inherent difficulties pertaining to treatment in spray form which depends for its success on wetting the insects as compared with fumigation.

TABLE 2. PERCENTAGE OF HILLS WITH "HEALTHY" FOLIAGE AT THE CONCLUSION OF THE PERIOD OF TREATMENT.

Treatment	Series I				Series II			
	1926	1927	1929	1928	1926	1927	1929	1928
Bordeaux mixture (4.6.50)	65.6	45.4	11.1	37.9	37.1	40.2	6.1	32.8
Bordeux mixture-nicotine spray	54.6	57.2	15.9	36.0	46.2	68.0	27.8	22.4
Bordeaux mixture-nicotine dust	56.5	84.6	56.5	19.3	61.6	61.9	50.1	15.2
None (check)	16.6	37.6	9.6	2.1	6.4	.2	.3	1.4
Copper-lime (20.80)	35.2	36.0	47.6	43.9	40.8	28.6	9.9	11.4
Copper-lime and nicotine dust	60.4	65.7	79.3	20.1	45.6	60.2	46.3	29.0

The comparative condition of the foliage following special applications during July for aphids and leafhoppers is represented in Table 2.

According to the condition of the foliage, as indicated in Table 2, it is evident that the foliage in the treated plots remained much "greener" than that in untreated plot; that in this respect dust mixtures, as applied, averaged nearly as good results as spray mixtures. Plots dusted with nicotine dust averaged superior results in three of the four seasons, the inferior results in 1928 being largely due to late blight infection following the suspension of the usual copper-lime application in preference for nicotine dust in anticipation of aphid injury. In the case of plot sprayed with bordeaux mixture and nicotine spray the results indicated that there was little, if anything, to be gained by the additional use of nicotine in the spray mixture when applied by such means. In 1928, when late blight was prevalent, it was evident that the use of copper in combination with nicotine, as is compatible only in such spray mixtures, had a decided advantage over the alternative method of dusting with nicotine with the enforced omission of copper in such applications owing to incompatability.

The yield of tubers from the various plots is given in Table 3-A.

Table 3-A. Comparative Yield of U. S. No. 1 Tubers from Plots Dusted and Sprayed with Various Treatments, Estimated in Bushels per Acre

Treatment	Series I				Series II			
	1926	1927	1929	1928	1926	1927	1929	1928
Bordeaux mixture (4.6.50)..	297	253½	98	276½	207	181½	84	228½
Bordeaux mixture-nicotine spray..................	324½	274	106	279	219	214½	90½	227
Bordeaux mixture-nicotine dust	317	316	133½	283	215½	242½	98½	222½
None (check).........	313	251	91	271½	209	155	(a)65½ (b)72	168
Copper-lime (20.80)........	285	286	99	279	219	169	98½	196
Copper-lime and nicotine dust..................	312	303½	107	306½	237	230	149	247½

(a) Comparable check for sprayed plots.
(b) Comparable check for dusted plots.

Table 3-B. Percentage Increase or Reduction in Yield in Comparison With the Untreated Plot

Treatment	Series I				Series II			
	1926	1927	1929	1928	1926	1927	1929	1928
Bordeaux mixture (4.6.50)........	—5.1	+ .9	+ 7.6	+ 1.8	— .9	+17.0	+28.2	+36.0
Bordeaux mixture-nicotine spray...	+3.6	+ 9.1	+16.4	+ 2.7	+ 4.7	+38.3	+38.1	+35.1
Bordeaux mixture-nicotine dust ...	+1.2	+25.8	+46.7	+ 4.2	+ 3.1	+56.4	+50.3	+32.4
Copper-lime (20.80)	—8.9	+13.9	+ 8.7	+ 2.7	+ 4.7	+ 9.0	+36.8	+16.6
Copper-lime and nicotine dust....	— .3	+20.9	+17.5	+12.8	+13.3	+48.3	+106.9	+47.3

According to the yield of tubers it is evident that the most marked increases from treatment were obtained during the seasons 1927 and 1929 in both series of experiments and in 1928 in Series II only. In these experiments the plots receiving applications of nicotine dust, whether previously sprayed or dusted, had much greater increases in yield in 9 out of 10 instances than any other treatments applied. On the other hand in 1926 and in Series I in 1928 there were comparatively little differences between treated and untreated plots. It will be noted that in Series I there were comparatively little or no increases in yield from plots sprayed or dusted with copper-lime applications, even where nicotine was added to bordeaux mixture for the better control of aphids and leafhoppers. Plots in this series were planted early in the season. In Series II there was a marked increase in yield from plots receiving such treatments, except in 1926. These plots were planted at mid-season.

Conclusions

Nicotine dust was superior to nicotine spray, as applied, in checking aphid development and hopperburn on potato foliage. These results were followed in the majority of cases by marked increases in yield of tubers.

Such results were in a large measure due to the relatively simpler task of applying nicotine dust for a desired purpose as compared with the difficulties encountered in striving for the same results with a sprayer.

PENETROL AS AN ACTIVATOR FOR NICOTINE

By John L. Hoerner, *Crop Protection Institute*

Abstract

Penetrol shows definite activation properties when used with Nicotine and does away with the disadvantages of soap.

Thorough study of Penetrol, a sulfonated oxidation product of petroleum, has shown many useful and desirable properties as a nicotine activator. The first uses of nicotine as a contact spray showed the necessity of an activator or a material which would effect a better contact of the nicotine with the insect. Since that time many materials have been tried for this purpose, but soap has been quite generally recommended. Notwithstanding the general recommendation for soap as a nicotine activator, it is probably true that because of the well known objections to its use, much less soap is used than is generally supposed. It is easy to understand this omission after one experiences the difficulty of dissolving soap, even in soft water.

In many sections the water available for spray solutions is quite hard, and the handling of the soap is far more troublesome. The solution of soaps in hard water is exceptionally difficult because of the formation of insoluble calcium and magnesium soaps on the surface of the pieces or particles of undissolved commercial soap. The calcium and magnesium precipitates formed in the hard water also tend to clog the spray nozzle.

The use of soap with, before and after arsenicals has long been recognized as a questionable and hazardous spray practice,[1] and is generally not recommended by entomologists.

Another important factor is the lack of standardization of the soaps commercially available to growers. Soaps are made from a wide variety of vegetable and animal oils which are saponified by many methods. Although the water content is specified it varies in different soaps from 30 to 70% at the factory and changes appreciably after standing in the open for some time. The causticity of soaps varies considerably. Even if a soap of very definite analysis is recommended it is a difficult problem for the farmer to specify and to obtain the soap he wants.

Penetrol is a free-flowing, easily miscible activator for nicotine. It does away with the agitation of soap in hot water, and the difficulties of solution in hard waters.

A comparison of the compatibility of both Penetrol and soap in water of varying degrees of hardness is shown in the accompanying photograph. The Penetrol was first mixed with three times its volume of water before the final dilution was made. The soap was dissolved directly in the final volume of hot water. The photograph was taken after the dilutions had stood eight hours. It will be noted that there is no marked change in any of the Penetrol samples. The soap shows a variation from a clear solution in distilled water to a heavy curdy precipitate in the hard water.

A study of the surface waters of the United States would seem to indicate that the maximum dissolved solids of a water for spray purposes would be somewhere in the range of 1000 to 2000 parts per million.[2] Because of the difficulties in obtaining samples of natural waters from the various sections of the country, the waters used in the tests were made in the laboratory, and they are considered sufficiently satisfactory for the purpose. The following analysis was used as a basis of what the writer terms a moderately hard water:

[1]Metcalf and Flint. Destructive and Useful Insects. 236, 1928.

[2]Hardness of the Waters of the United States. Ind. and Eng. Chem., V. 12, p. 1181, 1920.

Calcium Carbonate	281 p.p.m.
Calcium Sulfate	2 "
Magnesium Sulfate	501 "
Sodium Sulphate	26 "
Sodium Chloride	25 "
Total dissolved solids	835 p.p.m.

The following water samples were prepared in the above proportions:

	Total Dissolved Solids
1. Hard water	1670 p.p.m.
2. Moderately hard water	835 "
3. Moderately soft water	415 "
4. Distilled water	0 "

The soap used was commercial potassium fish oil soap containing 30% water.

No burning to foliage has resulted in any of the laboratory and field tests made with Penetrol-arsenical sprays. In these tests lead arsenate, Paris green, and calcium arsenate have been used with Penetrol diluted at the rate of ½%.

A number of different tests have shown Penetrol to be compatible with Bordeaux. Although soap is used with Bordeaux in some places, it makes an illogical spray mixture because of the insoluble calcium soap formed which may clog the nozzle and counteract the very spreading properties that are needed.

Penetrol is a definite standardized homogeneous chemical product. The following table is one of many obtained in the course of the writer's work, showing its comparison with soap as a nicotine activator:

Comparative results obtained by spraying Penetrol-nicotine and soap-nicotine combinations on *Macrosiphum* sp. on *Helenium* sp. Temperature at time of spraying 75. Relative humidity 51.

Materials Used	Counted Insects	% Dead 2 Days
Penetrol 1–200, Nicotine 40% 1–800	231	98
Fish Oil Soap 1–200, Nicotine 40% 1–800	184	98
Penetrol 1–400, Nicotine 40% 1–800	198	97
Fish Oil Soap 1–400, Nicotine 40% 1–800	172	96
Penetrol 1–200, Nicotine 40% 1–4000	409	92
Fish Oil Soap 1–200, Nicotine 40% 1–4000	236	75
Penetrol 1–200, Nicotine Sulphate (40% nicotine) 1–800	167	98
Fish Oil Soap 1–200, Nicotine Sulphate (40% nicotine) 1–800	203	87
Untreated check	400	1

In the above table the *Macrosiphum* was selected as an aphid that is more resistant to insecticides.

The following data shows typical activation results. The weaker dilutions were selected to illustrate the activation principle:

Plate 7

Photograph showing dilutions of Penetrol and soap, one part to 200 parts of water differing in degree of hardness.

Materials Used	No. of Counted Aphids	% Dead 2 Days
CHRYSANTHEMUM APHID, *Macrosiphonella sanborni* Gill		
Untreated check	463	0
Penetrol 1–400, Nicotine 50% 1–10,000	387	87
Fish Oil Soap 1–400, Nicotine 50% 1–10,000	173	14
GREEN PEACH APHIS, *Myzus persicae* Sulz.		
Untreated check	93	0
Penetrol 1–400, Nicotine 50% 1–10,000	154	89
Fish Oil Soap 1–400, Nicotine 50% 1–10,000	134	4
CITRUS APHIS, *Aphis spiraecola* Patch.		
Untreated check	517	1
Penetrol 1–400, Nicotine 50% 1–10,000	476	99
Fish Oil Soap 1–400, Nicotine 50% 1–10,000	289	89

The use of Penetrol as an activator for nicotine has given consistently better results than potassium fish oil soap on all the species of aphids tested.

LEAFHOPPER ASSOCIATION ON APPLE

By W. J. SCHOENE, *Entomologist Virginia Agricultural Experiment Station*

ABSTRACT

A brief report of life history studies and field observations of the leafhoppers in Virginia apple orchards. Serious injury to fruit and foliage has resulted from the feeding of six species. The seasonal abundance of *Empoasca fabae*, *E. maligna*, *Typhlocyba pomaria*, *Erythroneura hartii*, *E. obliqua*, and *E. dorsalis* are given and thel ife history of the last three species at Blackburg, Virginia shown in chart form.

Attention was directed to the problem by a general leafhopper infestation of apple orchards extending over a number of years. The injury was observed to be much more serious in some orchards than others. Certain well-cared-for plantings of apples were subject to infestation year after year. The insects were observed in all of the orchard sections of the State. Six species of leafhoppers have contributed to the injury; namely, *Erythroneura hartii* (Gillette), *E. obliqua* (Say), *E. dorsalis* (Gillette), *Empoasca fabae* (Harris), *E. maligna* (Walsh), and *Typhlocyba pomaria* (McAtee). It was proposed in this study to determine the importance, seasonal occurrence and the life history of the several species. This paper includes a summary of the field notes and life history charts of the three species of *Erythroneura*. The work of a very few leafhoppers causes such serious curling of the leaves that the growth of the twig is greatly reduced.

In addition to the curling of the foliage of the tender terminals, the older leaves are often badly stippled by the feeding of both the adults and the nymphs. When the insects are numerous the leaves are severely injured and become shell gray in color. Many of the leaves fall pre-

maturely and the fruit is seriously spotted so that its value is reduced. The leafhopper injury is usually more conspicuous during dry weather. It is believed that wet weather is unfavorable to the insects.

The numbers of leafhoppers have varied greatly in different orchards. This variation seems to be due to the difference in the succulence of the foliage. The insects are usually more numerous in the orchards that receive good care.

THE HABITS AND INJURY OF EACH SPECIES. *Empoasca fabae*—This leafhopper is generally distributed in Virginia orchards. The injury to apple foliage has been previously described by Ackerman (1) and Ball (2). The tender leaves are badly curled. On apple the insect is primarily a pest of nursery stock but the nymphs can usually be found in the early season on the tender terminals of bearing trees. Their numbers decrease in midsummer. As the season advances the growth of the foliage becomes less rapid and also less attractive to this species. *E. abae* hibernates as an adult. This is the only one of the six species that confines its attack to the tender leaves.

Empoasca maligna—This leafhopper seems to be generally distributed in Virginia but as a rule specimens are difficult to find. It has been collected in one orchard for three seasons and in 1927, was sufficiently numerous to cause injury. In this instance the adults were present from June 1 to July 10. The adults and nymphs feed on the older foliage causing the characteristic stippling. Adults inclosed in large lantern globes over apple at Blacksburg during the summer of 1928, deposited eggs. The eggs hatched in the spring of 1929, and the insects reached maturity in June. Our observations indicate only one brood.

Typhlocyba pomaria—This species is generally distributed and often very abundant. It is the most injurious leafhopper in Virginia orchards. The life history is similar to that observed by Lathrop (3) in the Hudson Valley. The insect hibernates in the egg stage. The adults appear about May 20. The first brood is present in maximum numbers during the first two weeks in June, but each season they have been studied, many adults have been found with a parasite attached to the abdomen. The numbers of adult leafhoppers are soon reduced. The parasite is one of the Dryinidae. In some of the collections in 1927, as high as 70% were found parasitized. The adults of the second brood begin to appear about the first of September and during three seasons they have been very numerous that month. To find thirty nymphs and adults on the underside of a single leaf was not unusual. The collections and observations indicate that there is a rather distinct gap between the periods

of the first and second brood of adults. It is believed that some adults continue to feed and deposit eggs until the first of November. This species attacks the older foliage. Some of the varieties are more seriously injured than others. Of the commercial apples, Stayman Winesap is most severely injured.

Erythroneura hartii, E. dorsalis, and E. obliqua—will be considered together. Their feeding habits are similar in that they are generally found on the older leaves on the inside of the tree. The life history of *E. hartii, E. dorsalis, E. obliqua* have been studied during the past three seasons. The results are presented in Fig. 18. The economic im-

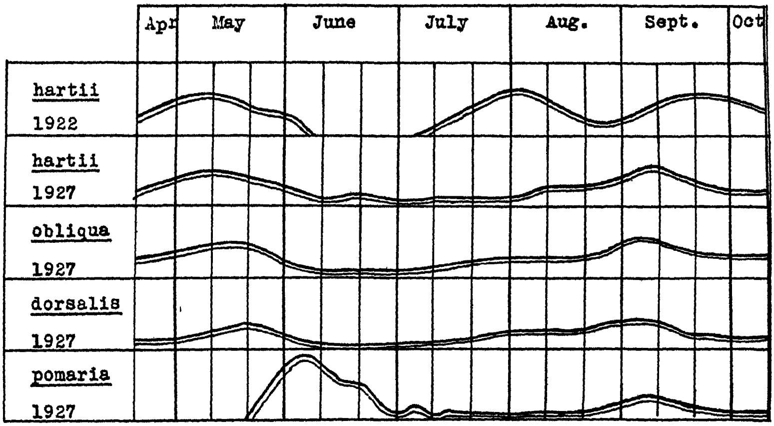

FIG. 18.—Relative abundance of adult leafhoppers at Staunton in 1927, and *Erythroneura hartii* at Leesburg in 1922.

portance of these species was first mentioned by Stearns (4). As soon as the leaves begin to separate from the developing apple bud in early spring the overwintering leafhoppers begin to feed. Later in the season they attack the older foliage. In rearing these insects in the laboratory it has been noted that they prefer the fully developed foliage. It is believed that rains reduce their numbers, and that dry weather is favorable. No insect or fungus parasites have been observed attacking these species.

THE COLLECTION OF LEAFHOPPERS. To determine the species present and the relative numbers of each, collections have been made at intervals during the summer in several orchard sections. For the purpose of this report the collections made at Staunton in 1927, will be presented. The insects were sufficiently numerous so that they could be secured by a few sweepings with a net. The results are shown in Fig. 18.

The numbers collected being represented by the height of the line above the base. For the purpose of comparison the seasonal distribution of *E. hartii* at Leesburg in 1922, as indicated by Stearns (4) is reproduced. According to Stearns the overwintering adults disappeared June 9 and the adults of the first brood began to appear during the first week in July. The height of abundance for this brood was apparently August 1, and the height of abundance for the second brood occurred during the last ten days of September. The collections made at Staunton in 1927, indicate a slightly different life history. The adults of *E. hartii*, *E. dorsalis*, and *E. obliqua* were collected at weekly intervals during the entire summer, although the numbers taken during June and July were small. From these records it is believed that *E. hartii* was largely one brooded in that year. This is accounted for by the difference in the seasons, as growth started about twenty days earlier in 1922, than in 1927. As indicated in the chart adults of *T. pomaria* were present in large numbers during the first week in June but during the latter part of June a large percentage of these adults became parasitized so that at the end of the month there were very few living individuals present.

LIFE HISTORY STUDIES. For three seasons leafhoppers have been reared in breeding cages in the insectary, in the greenhouse and in the nursery. During 1929, an effort was made to study the life history of the three species of *Erythroneura* in the insectary. The results are summarized in Fig. 19. The adults of the different species were collected in the orchard about April 20 and placed on apple trees planted in pots. The number of leafhoppers used in each cage varied. There were usually six to ten females in each cage. The leafhoppers were permitted to feed and deposit eggs on the foliage of one tree for a number of days, after which they were transferred to another tree, the foliage of the original plant being watched for the appearance of nymphs. As these nymphs appeared they were transferred to other plants. By making frequent transfers of both adults and nymphs, it was possible to determine the time during which eggs were being deposited and the period during which nymphs were present. In Fig. 19 a number of dotted lines are used to show the continuous emergence of nymphs. In this life history study efforts were made to supply plants of uniform size with healthy foliage, but difficulty was experienced with apple scab and red spider. In some instances, the foliage dropped prematurely.

It is believed that a period of twenty-five to thirty days is required for the eggs to hatch and a similar period for the nymphs to mature. The overwintering adults continue to deposit a few eggs each day over a long period, possibly as long as two months. The result is that nymphs are continuing to hatch for an equally long period. The first brood

adults of all three species matured about July 1 in 1929. The first adults to reach maturity deposited eggs, whereas, those adults which developed later did not deposit eggs during 1929. The same individuals were still present in the breeding cages at the close of the season. *E. dorsalis* and *E. obliqua* feed and deposit eggs readily on small apple trees growing in pots in the insectary. It appears that they do well on the tough leathery foliage which results when the trees are grown as described.

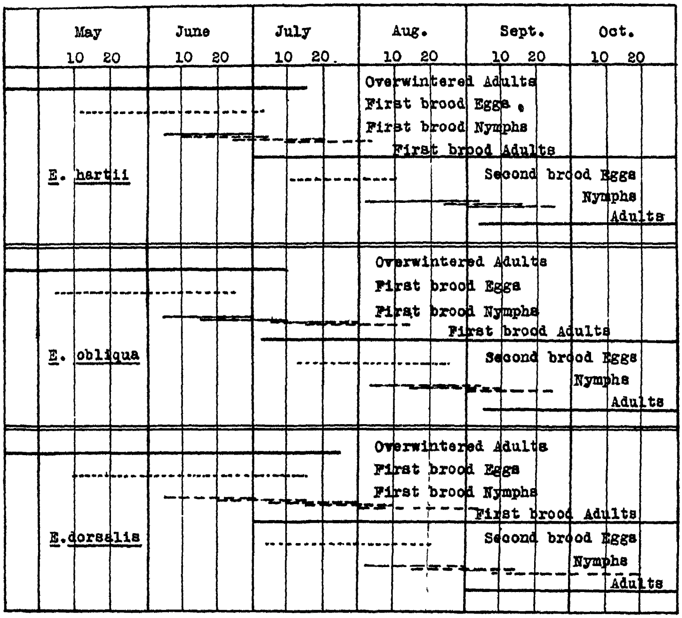

FIG. 19.—The life history of *Erythroneura hartii, E. dorsalis, and E. obliqua* at Blacksburg, Virginia in 1929.

SUMMARY—Of the six species found on apple, *Empoasca fabae* is the only one that confines its attacks to the tender foliage. It is rarely found on the older leaves. The young leaves are severely curled. *F maligna* has been unimportant during the past three seasons. *Typhlocyba pomaria* is the most injurious leafhopper, it passes the winter in the egg stage and has two broods. *Erythroneura hartii*, *E. dorsalis*, and *E. obliqua* are frequently present in large numbers.

REFERENCES

1. ACKERMAN, A. J. 1919. U. S. D. A. Bull. 805:1–20.
2. BALL, E. D. Correct names of the leafhoppers infesting the apple and potato. 1924. Jr. Ec. Ent. 17:594.
3. LATHROP, F. H. 1918. Jr. Ec. Ent. 11:144–148.
4. STEARNS, L. A. 1928. *Erythroneura hartii* an occasional leafhopper pest on the apple. Va. Ag. Exp. Tech. Bull. 33:1–16.

THE ROSY APHID IN RELATION TO SPRAY PRACTICES

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Abstract

Experiments carried out with lime-sulfur, bordeaux mixture and oil emulsions, containing nicotine extracts, against the rosy aphid are described. It is concluded that the newly-hatched nymphs are susceptible to timely applications, preference being given to lime-sulfur and nicotine sulfate at standard strengths.

The rosy aphid (*Anuraphis rosae*) is one of the major pests of apple orchards in New York. The importance of the insect is shown by the record of the injury in a permanent plat of 13 unsprayed Rome trees in the entomological orchard on the Station grounds:—1921, 11.20 per cent aphid apples; 1924, 46.36 per cent; 1925, 15.86 per cent; 1926, 14.05 per cent; 1927, 47.40 per cent; 1929, 44.6 per cent. Severe infestation causes marked depreciation in both yields and quality of the fruit.

Each year tests are conducted with the object of answering certain pertinent questions bearing on the control of the insect. Some of the points on which it was hoped that such experiments would shed additional information are as follows: (1) The period at which the most effective control is to be obtained; (2) the limits of the period during which commercial control may reasonably be expected; (3) the comparative aphiscidal merits of some of the common oil sprays; and (4) the merits of free nicotine as compared with nicotine sulfate when incorporated in oil sprays.

The data obtained from a series of tests in one orchard only are presented. However, it should be stated that the figures given are for the most part typical of the results obtained in other efforts. The orchard in question consists of 240 Greening trees 28 years old. The experiment provided for 21 treated plats and 15 check trees variously distributed thruout the planting. The susceptibility of the rosy aphid was considered with respect to treatment with lime-sulfur and bordeaux mixture at standard strengths, each containing nicotine sulfate. Various oil sprays, with or without nicotine preparations, were also tested. The different sprays were applied under as nearly comparable conditions as possible at the rate of 10 to 12 gallons per tree. The spraying was done entirely from the ground and each tree, with respect to treatment, was completed at one operation. The work was done by the same operator and the different plats were sprayed as uniformly as it was possible to do. The treatments were timed with reference to different stages of blossom bud development. Certain applications were made when the tips of the

leaves of the more advanced blossom buds were projecting as much as one-half inch, while others were made before the pink color showed appreciably in the central buds of the blossom clusters. Treatments were also given at an intermediate period. The results, which are based on counts of over 250,000 apples are summarized as follows:

Fifteen unsprayed trees with a total production of 26,280 fruits had 18,692 centers of infestation in leaf clusters and terminal growth and 13,627 aphid apples. The number of centers of infestation averaged 1,246 per tree and aphid apples averaged 908 per tree. The percentage of aphid apples at time of picking was 51.65.

Two plats, comprising 8 trees each, and sprayed with lime-sulfur 1 to 40 with 1 pint of nicotine to 100 gallons of water yielded 17,081 and 9,081 apples respectively. The total number of centers of infestation were respectively 280 and 790, with an average of 35 and 99 per tree, according to the plat. The total number of aphid apples was 48 and 280 respectively, or 0.28 and 3.06 per cent of the yields.

Of four types of oil sprays tested, only one preparation, a commercial brand, approximated the degree of protection obtained with the lime-sulfur and nicotine sulfate spray. Nine trees treated with the spray oil (4 per cent) yielded 13,176 apples of which 981 showed aphid injuries. Aphid apples constituted 7.49 per cent of the crop. The total number of centers of infestation of leaf clusters and terminal growth on the nine trees was 3,152, making an average of 239 centers of infestation per tree. According to the opinions of consulting fruitgrowers, the protection could be designated as "commercial control."

With combinations of lime-sulfur and nicotine sulfate, insecticidal efficiency varied with the nicotine content. At the rate of 1 pint of nicotine sulfate to 100 gallons of the spray mixture the percentage of aphid apples per tree was 0.28; ½ pint, 7.38; and ¼ pint 12.46. With present knowledge 1 pint of nicotine sulfate to 100 gallons of dilute lime-sulfur appears to meet practical needs, considering control of the pest, safeness of the treatment to the trees, and outlay of money that growers can reasonably afford to secure needed protection.

No appreciable differences in insecticidal efficiency were noted between nicotine sulfate and free nicotine, using as the carrier a lubricating oil emulsion (3 per cent oil) containing gum arabic as the emulsifier. The percentage of aphid apples on trees sprayed with nicotine sulfate was 7.02; with free nicotine 6.21.

Nicotine sulfate in lime-sulfur proved consistently more effective than bordeaux mixture containing the same amount of nicotine sulfate.

Certain oil sprays low in aphiscidal properties displayed improvement

in insecticidal efficiency upon the addition of nicotine sulfate. The percentage of aphid apples on trees sprayed with paraffin oil (4 per cent) was 43.60; with paraffin oil (3 per cent) containing 1 pint nicotine sulfate 7.02.

To secure maximum control of the rosy aphid it is considered that the spray should be applied during the period following the separation of the tips of the leaves of the developing fruit buds and before the pink color shows appreciably in the central buds of the blossom clusters. Spraying in the late pink or calyx period has consistently given inferior control.

THE EFFICIENCY OF VARIOUS INSECTICIDES IN CONTROLLING THE BUD MOTH

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Abstract

The eye-spotted bud moth is a major apple pest in certain sections of western New York. Severe infestations are capable of defoliating orchards and destroying the crop. There are two periods when effective treatment may be practiced, namely, early in the spring when the overwintering larvae become active and during the summer when the eggs are hatching. In heavily infested orchards nicotine was the only material used to which the overwintering larvae were noticeably susceptible. Lead arsenate was apparently of little value early in the season, but in the summer during the egg hatching period thoro applications of either lead arsenate or nicotine were effective.

As described in a previous paper[1] the eye-spotted bud moth (*Spilonota ocellana* Schiff.) is a major apple pest in certain sections of western New York and is causing considerable apprehension among fruit-growers in that area. The insect attacks both fruit and foliage at two different periods during the season. In the spring the overwintering larvae feed on the tender foliage, blossoms, and newly set fruits and again during August the young larvae skeletonize areas in the foliage and attack the fruit. Badly infested orchards are often defoliated and the crop rendered practically worthless.

A heavily infested orchard was used this past season to determine the value of our present spray-program in combating severe bud moth outbreaks and to discover, if possible, other means of control.

Life Cycle. The bud moth has one generation each year. The winter is passed as an immature larva in a hibernaculum, usually located at the base of a bud or fruit spur. The caterpillars become active in the

[1]Harman, S. W. The bud moth in western New York. Journ. Econ. Ent. **22**[4]: 660–662. 1929.

spring about the time green tips begin to show on the buds. Prior to emerging an opening is made in one end of the winter shelter and when conditions are favorable the larva makes its exit and burrows into a dormant bud or enters at the tip where the green tissues are showing. As the leaf and blossom buds unfold they are tied together with silken threads, forming a shelter in which the larvae feed on the tender leaves and blossoms and later the newly set fruits.

Full grown caterpillars pupate in the webbed clusters and the moths are active during July and the forepart of August. Eggs are laid mainly on the under surfaces of the foliage and the new brood of caterpillars may be observed about the middle of July. These larvae soon establish themselves beneath silken shelters along the midribs on the lower leaf surfaces where they skeletonize small areas of the leaf and feed on those portions of fruits that come in contact with the foliage. The silken web is enlarged as feeding progresses so that the larvae are continuously protected during the period. Later on in September the partially grown caterpillars leave the foliage and construct winter quarters in protected positions on the twigs and smaller branches.

Spray Program. Attempts at control were directed against the bud moth at two different periods during the season: (1) In the early spring when the caterpillars were emerging from their winter quarters, and (2) during the summer when the new brood of larvae were making their appearance.

Spraying for the Overwintering Larvae. This past spring the caterpillars issued from their winter shelters during a period of four weeks, commencing when the green tips on the buds were first showing and continuing up to the time of the pink stage of the apple blossom buds. This emergence period was probably influenced by abnormal weather conditions. The first nine days of April, with one exception, were unusually warm and were followed by cool weather for the remainder of the month. This early warm spell was sufficient to start emergence of the larvae, but the cool weather immediately following checked their activities so that the emergence dragged along varying with temperature changes until the more seasonable weather in May brought out the remaining insects.

The efficiencies of the various treatments were determined by counting leaf and blossom clusters and recording as either clean or infested.

Nicotine was the one and only material that gave commercial control of the bud moth in the early season treatments. One pint of nicotine sulfate (Blackleaf 40) was hardly adequate to cope with a severe in-

festation, double this dosage being much more effective. When used with linseed oil or fish oil (one quart in 100 gallons) or with lubricating oil emulsions, the effectiveness of the nicotine was apparently increased. Larvae were found dead in the hibernacula as well as on the foliage treated with nicotine solution, which indicated that the caterpillars were susceptible to treatment just previous to emerging, and also after emergence if coated with the spray.

The effectiveness of nicotine at various strengths when applied at the green tip, delayed dormant, and prepink stages is expressed in the following table:

EFFICIENCY OF EARLY SEASON APPLICATIONS OF NICOTINE SULFATE AGAINST THE OVERWINTERING CATERPILLARS OF THE BUD MOTH

Amount and Time of Application	Percentage of Clean Foliage Clusters
1 pint at delayed dormant	41
1 quart at delayed dormant	84
1 pint at green tip; 1 pint at delayed dormant	84
1 quart at green tip; 1 pint at delayed dormant	88
1 quart at green tip; 1 quart at delayed dormant	91
1 quart at green tip; 1 pint at delayed dormant; 1 quart at prepink	99
Check	16

Among the materials used in the early season treatments which gave little or no promise in combating caterpillars in heavily infested plantings, the following should be mentioned:

Lime-sulfur solution
Bordeaux mixture
Lead arsenate
Calcium arsenate
Paris green
Lubricating oil emulsions
Lubricating oil emulsion saturated with paradichlorobenzene
Miscible oil

SPRAYING FOR THE SUMMER BROOD OF LARVAE. In western New York three sprays are usually applied during the summer after the calyx application to control the codling moth. These treatments are made about the first and middle of July and early in August. During the past season the eggs of the bud moth commenced hatching by the middle of July, and by the last week in the month the hatching was at its peak point. The second cover spray was therefore applied at the beginning of the egg-hatching period, while the third cover spray or August-first application came after the major portion of the larvae had hatched. Experimental plats were laid out to determine the value of these sprays in controlling the summer brood of larvae.

The young caterpillars produce a characteristic type of leaf injury by skeletonizing small areas on the lower leaf surfaces, usually along the midrib, and the extent of infestation was determined by recording the number of leaves clean and infested.

All spraying was done from the ground by directing the nozzle upward and outward from the center of the tree to coat the lower leaf surfaces.

The following table gives the more outstanding results of the summer applications. It appears that lead arsenate controlled the pest when used in both applications and that nicotine sulfate was most effective when applied at the beginning of the egg-hatching period.

EFFECTIVENESS OF SUMMER SPRAYS IN CONTROLLING NEWLY HATCHED LARVAE

Material	Date Applied		Percentage of Clean Foliage
Lead arsenate, 3 lbs. in 100 gals	July 18	——	58
Lead arsenate, 3 lbs. in 100 gals	July 18	Aug. 1	93
Lead arsenate, 3 lbs. in 100 gals. and	July 18	Aug. 1	98
nicotine sulfate, 1 pt	——	Aug. 1	
Lead arsenate, 3 lbs. in 100 gals. and	July 18	——	99
nicotine sulfate, 1 pt	July 18	——	
Lead arsenate, 3 lbs. in 100 gals. and	July 18	——	96
nicotine sulfate, 1 pt. with 5 lbs. soap	——	Aug. 1	
Lead arsenate, 3 lbs. in 100 gals. and	July 18	——	86
nicotine sulfate, 1 qt. with 5 lbs. soap	——	Aug. 1	
Bordeaux mixture with calcium arsenate, 2½ lbs. in 100 gals	July 18	Aug. 1	84
Check	——	——	29

CONCLUSIONS. As a result of these studies it appears that there are two periods during the season when severe outbreaks of the bud moth may be effectively combated:

1. Early in the spring just before and during the emergence of the overwintering larvae from their hibernacula.

2. Later in the season from about the middle of July to early in August when the eggs are hatching.

Nicotine was the only material used to which the overwintering larvae were noticeably susceptible. Arsenate of lead was apparently of little value early in the season, but in the summer during the egg-hatching period thoro applications of either lead arsenate or nicotine were effective.

NOTES ON THE PISTOL CASE-BEARER

By L. M. Peairs and Edwin Gould

Abstract

An account of an unusual outbreak of the pistol case-bearer in the eastern panhandle of West Virginia which the ordinary orchard spray practice of the region failed to control. Tests of different insecticides showed nicotine sulphate with penetrol to be most effective, applied just after the hatching period. An emergency application of 67,000 gallons of spray was made in one orchard for this insect.

An unusual outbreak of the pistol case-bearer developed in the eastern panhandle of West Virginia during the past few seasons. While the insect is fairly easy to find all over the section, the severe infestation was localized in one orchard of about 4500 trees, 20 to 25 years of age in Jefferson County. The owner of the orchard states that the case-bearer has been doing considerable damage for at least four seasons but it was not until the season of 1927 that the attention of the Experiment Station was first called to the orchard. In 1928 some efforts to control the insect by modifications of the ordinary spray program were made but were largely unsuccessful. Still further application of the special materials in the regular spray treatments during the spring of the present year 1929 likewise failed to reduce the number of insects enough to prevent serious damage. Among the treatments tried in 1928 and the spring of 1929 were excessive strengths of lime sulphur; different kinds of miscible oils; the use of large quantities, up to 12 gallons to 100 gallons, of arsenate of lead; use of nicotine sulphate and nicotine sulphate with Penetrol.

The situation seemed to require special study so it was undertaken as a project at our field laboratory located at Inwood. Continuation of the tests of insecticides formed a part of this study while the determination of details of life history constituted the other part of the work.

It seemed likely that the resistance of the insect to the ordinary spray treatments was due to two things: (1) its protective case which is virtually impenetrable by any of the contact sprays, and (2) to its feeding habits. Early in the spring it feeds largely within the buds of the apple; later it feeds on the surface of the leaf but eats very small quantities of food and probably avoids surfaces coated with poison although that point was not definitely established. It was hoped, therefore, that we might be able to control it by spraying immediately after the hatching period before the young larvae had constructed their protective cases. It was thought also that they might be more susceptible to the action of arsenicals during the early feeding period than they appeared to be in the spring.

It was found that the insects continued to feed until about the middle of May and then began their preparation for pupation. The first pupae were formed May 22 and the first adults emerged on June 8. The emergence continued until about July 3. The majority of the moths appeared during the period from June 19 to June 21. Egg laying began on June 9 and continued through a period of about 27 days, the peak of oviposition being about June 21. The first hatching was observed on June 20; the majority of the eggs had hatched by July 14 but hatching of stragglers continued until after July 18. The eggs were laid on both surfaces of the leaves but the majority of them, 92.9 per cent, were placed on the upper surface of the leaf. The young larva hatches out through the bottom of the egg shell, eating its way into the interior of the leaf, where it feeds, for a period of about 3 days, as a miner. It emerges through a small hole on the under side of the leaf, with its first protective cocoon already partly formed. It continues to feed as a semi-miner, making a small hole through the surface of the leaf and extending the body as far as it can reach inside the leaf to feed. Little, if any, feeding is done on the surface of the leaf during the late summer.

Before October 1 the insect completes its cocoon and attaches it to a twig for the winter. This hibernation takes place during the period from September 20 to October 5.

As soon as the feeding habits of the newly hatched larva were observed, it became obvious that an arsenical poison would probably be ineffective for the insect at this stage, so our tests were concentrated on various contact insecticides. These included nicotine sulphate, derrisol, pyrethrum compounds and oils. The first three mentioned were used alone and also with the penetrol as an activator. Varying results were secured, but in laboratory tests and controlled field tests, the kill with nicotine sulphate, 1–800, plus ½ per cent penetrol, was practically 100 per cent.

Penetrol was not yet on the market but arrangements were made to secure a quantity sufficient for an emergency treatment of the orchard affected. Spray rigs from a number of neighboring orchards were secured so that the application might be made in as short a period as possible. The spray was put on between July 17 and July 27, with weather conditions being ideal on the days when spraying was done. Results varied according to the efficiency of the spray outfits and of the men holding the nozzles, from less than 60 per cent kill to over 90 per cent. Average kill based on counts of 11,852 insects after the treatment was 78.92 per cent. The quantity of spray required to treat the orchard was about 67,000 gallons or more than 15 gallons per tree.

The results were considered to be very satisfactory and the treatment furnished a valuable demonstration of the fact that results in spraying depend very largely upon the manner in which the material is applied, as well as upon the material itself. The quantity of spray applied was probably more than twice as much as had ever before been put on in one treatment in this orchard and it is extremely probable that the infestation has been built up as a result of indifferent spraying and dusting. The orchard is well cared for in other respects, conditions are favorable for development of the insects, and the spraying has not been sufficiently thorough to keep them in check. Further tests of materials which may be added to sprays in the regular program to control this insect are in progress.

TOXICITY OF SPRAYS AND SPRAY INGREDIENTS ON PEAR PSYLLA NYMPHS

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Abstract

Experiments were conducted on nymphs of the pear psylla, *Psyllia pyripyri*, with various combinations of the following ingredients: Bordeaux (2-40-100), nicotine sulfate, free nicotine, Derrisol, M-P Insecticide, white petroleum oils, pine oil, Hardwood neutral oil, and Penetrol. The trials were made in commercial orchards, using a large spray rig. All the ingredients showed toxicity toward psylla nymphs at the various strengths used. The percentage of dead nymphs varied directly with the proportion of white oil, but nicotine (1-3200) showed a certain toxicity which appears to be but slightly increased by larger dosages. The several ingredients when mixed seemed to increase the destructiveness of the resultant mixture by an amount equal to the sum of the specific toxicities of the components. It is indicated that the nicotine content of psylla nymph sprays can be considerably reduced provided other toxic materials are added which do not react unfavorably with the nicotine. The percentage of white oil can be reduced in the spray mixtures if nicotine in pine oil or Hardwood neutral oil be added. Pine oil and Hardwood neutral oil show promise of reducing materially the nicotine content of the regular spray. Penetrol in bordeaux with reduced nicotine dosage was tested the most extensively and appears to be safe to foliage during the spring application if normal temperatures prevail.

Two aspects of the investigation will be considered: (1) Tests of materials and mixtures whose effect on pear foliage was in doubt; and (2) trials of varying concentrations of nicotine in bordeaux and Penetrol.[1] The first series may be called "analytical tests" because an effort

[1]Penetrol is an oxidized, sulfonated oil product manufactured by the Kay Laboratories, Inc., West Nyack, N. Y. The material was kindly furnished by the makers. For a discussion of the properties of this product see Inman, M. T., Jr.—Sulfonated Oxidation Products of Petroleum as Insecticide Activators. Ind. and Eng. Chem. 21:542-3. 1929.

has been made to determine the amount of toxicity that each ingredient contributes to a spray mixture. The second series may be termed "commercial trials" since they were large scale experiments under practical orchard conditions. In both series untreated plats and plats receiving the "regular spray," consisting of bordeaux (2–40–100) and nicotine sulfate (1–800), were included for the purpose of comparison. However, before considering the results of the two sets it seems best to explain various details governing the experiments.

Technique of the Applications

All the trials were made in two commercial pear orchards, involving approximately 1100 trees treated, the trees being between 20 and 30 years of age. Applications were made by means of a large orchard spray rig maintaining 350 pounds pressure. A spray-gun was used with the operator on the ground. The experiments were conducted when practically all the eggs of the pear psylla (*Psylla pyripyri* Förster) had hatched, at which time nymphs of the five instars were present. An abundance of honeydew covered the trees since the infestation was severe. Details as regards arrangement of plats and season when work was done can best be described under the discussion of the two series of tests.

Series I. Experiments Aimed at Evaluation of Toxicity of Ingredients

The objects of these trials were somewhat broader than the heading indicates. They may be summarized as follows: (1) A search for combinations effective against pear psylla but cheaper than the regular spray; (2) determination of the safety to foliage and toxicity to nymphs of higher concentration of the petroleum "white oils" than had previously been used by the writer; (3) to determine whether the addition of nicotine to other materials would produce efficient control at reduced cost; (4) to learn what ingredients or mixtures are toxic to pear foliage; (5) tests of a number of commercial preparations, some of which had not been used previously on pear psylla.

In 1928, Dr. E. R. deOng suggested to the writer the addition of pine oil[2] and small amounts of nicotine to white oils for the purpose of in-

[2]This material was kindly furnished by E. W. Colledge, Jacksonville, Fla., thru the request of Dr. E. R. deOng. The brand is known as No. 33-B Pine Oil.

[3]"Hardwood neutral oil" is a name given to a product secured in the refining of by-products from the destructive distillation of wood. It was furnished thru the kindness of the refiners, The Hardwood Chemical Co., Inc., Buffalo, N. Y.

creasing the toxicity to insects with dilutions of white oil that would be safe to tender foliage. Mixture A was an attempt to follow this suggestion. Mixture B was devised to test the insecticidal value of Hardwood "neutral oil"[3] in the same manner.

During the spring of 1929 tests were made on pear trees on the Station grounds to determine the effect of some of the untried materials on pear foliage before attempting to use them in commercial orchards. Unfortunately, the trees were not infested, so the psylla experiments were conducted at the time of the summer brood (July). Since there was a total of 46 plats in this series, from four to eight trees were used for each test, the smaller number being used when testing materials whose safety to foliage was decidedly in question. Sample spurs were taken at random from every tree, and the live nymphs were counted previous to and after the applications. The data on check trees showed that 38.9 per cent of the psylla nymphs had disappeared between the beginning and end of the tests. Inasmuch as the time of initial counts, spraying and recounting was kept, it was possible to make corrections of the data to allow for natural decrease.

It is impossible in the space allowed to discuss all the tests, so only those showing general principles will be considered. Some of the results are shown in Table 1.

It may seem remarkable that water accounted for a loss of 34 per cent of the nymphs, but it should be noted that the spraying was done under a pressure of 350 pounds with a spray-gun. It is presumed that much of this loss was due to dislodging the insects. Bordeaux produced a loss of 65 per cent. As in previous unreported experiments, white oil (2 per cent) did not give very good results, but the addition of bordeaux slightly increased the kill. White oil (2.5 per cent) gave control comparable to the regular spray. It will also be noted that the addition of nicotine (1–3200) to white oil (1.5 per cent) in bordeaux gave very good results. Pine oil and neutral oil each showed considerable toxicity toward psylla nymphs, and this was increased by the addition of nicotine (1–3200). When bordeaux was added to the latter mixtures, the results were excellent. Derrisol (1½ pints per 100 gallons) alone was not very effective, but the addition of bordeaux brought the killing efficiency equal to that of the regular spray. Mixtures A and B were decidedly toxic, and it is reasonable to suppose that had these mixtures been used with bordeaux the control would have been higher. Mixture A seems to support the claim of Dr. deOng that the addition of pine oil and nicotine to white oil increases the toxicity to insects and permits lower concentrations of the petroleum white oils.

TABLE 1. TOXICITY OF SPRAYS AND SPRAY INGREDIENTS TO PEAR PSYLLA NYMPHS.

Spray No.	Material or Mixture	Percentage Killed Uncorrected	Percentage Killed Corrected	Effect of Ingredient Percentage of Kill	Effect of Ingredient Ingredient
1	Water alone	44	34	34	Water
2	Bordeaux mixture*	77	65	31	$CuSO_4$ & lime
3	(2) plus nicotine sulfate 1–800†	91	90	25	Nicotine 1–800
4	White oil 2%; kayso 1 lb. in 100 gals. (1–800)	83	81	47	2% white oil
5	White oil 2.5%; kayso 1–800	92	91	57	2.5% white oil
6	(4) plus bordeaux	86	83	2	Bordeaux
7	White oil 1.5%; bordeaux; nicotine sulfate 1–3200	96	95	22	Nicotine 1–3200
8	Pine oil 1%; kayso 1–800	56	51	17	Pine oil 1%
9	(8) plus free nicotine 1–3200	75	72	21	Nicotine 1–3200
10	(8) plus free nicotine 1–1600	75	72	21	Nicotine 1–1600
11	Pine oil 1%; bordeaux; free nicotine 1–3200	98	98	26	Bordeaux
12	Pine oil 1%; bordeaux; free nicotine 1–1600	98	98	26	Bordeaux
13	Hardwood neutral oil 1%; kayso 1–800	61	55	21	Neutral oil 1%
14	(13) plus free nicotine 1–3200	82	80	25	Nicotine 1–3200
15	(13) plus free nicotine 1–1600	90	88	33	Nicotine 1–1600
16	Hardwood neutral oil 1%; bordeaux; free nicotine 1–3200	99	99	19	Bordeaux
17	Hardwood neutral oil 1%; bordeaux; free nicotine 1–1600	95	95	7	Bordeaux
18	Derrisol 1–533	64	59	25	Derrisol 1–533
19	(18) plus bordeaux	97	92	33	Bordeaux
20	M-P Insecticide (a pyrethrum mixture) 1–560	71	67	33	M-P Ins. 1–560
21	(20) plus bordeaux	82	73	6	Bordeaux
22	Mixture A: White oil 1%; pine oil ¼%; free nicotine 1–2400; kayso 1–800; lime 1–400	92	90	—	
23	Mixture B: White oil 1%; Hardwood neutral oil ¼%; free nicotine 1–2400; kayso 1–800; lime 1–400	87	85	—	

*The bordeaux mixture used in all the tests consisted of copper sulfate 2 lbs.; hydrated lime 40 lbs.; water 100 gals.
†This is the regular foliage spray for pear psylla recommended in New York.

Perhaps the most striking results are shown in the last column of figures. These were secured by subtraction. For example, water gave a kill of 34 per cent and bordeaux showed a decrease of 65 per cent. This indicates that the lime and copper sulfate (called "bordeaux" for brevity) had a toxicity that was responsible for the death of 31 per cent of the nymphs. Similar reasoning and computing applies to the other ingredients used. When employed with white oil bordeaux showed little increase in kill over the oil alone. Similar effects were observed when bordeaux was added to other mixtures except with Derrisol and perhaps with pine oil and nicotine, where the bordeaux seemed to add an efficiency equal to that obtained with bordeaux and water.

Rather startling results are shown in regard to the toxicity of nicotine. It will be noted that, with one exception all concentrations used, when added to other materials, seemed to increase the loss by percentages ranging between 21 and 25. If all the results with nicotine (1–3200), some of which have not been given in Table 1, are averaged, the mean is 24 per cent. Another notable result is the fact that the various concentrations of nicotine, Derrisol (1–533), pine oil (1–100), and Hardwood neutral oil (1–100) gave toxicities that are quite similar. If chemical or physical combinations occurred between the nicotine and the other materials or if "activation" of nicotine took place, the results do not seem to indicate it. Apparently in all dosages using more than ¼ pint of nicotine per 100 gallons the excess nicotine was unnecessary so far as the effect on the nymphs was concerned. However, data not included here seem to indicate that the heavier dosages of nicotine assist in preventing reinfestation. In general, it appears that the toxicity of the several materials is addative and that either each material kills the insect or reaches the insect's body in a specific manner. This is shown by an analysis of Mixtures A and B. If the assumption be made that the effectiveness of white oil decreases in the same proportion as shown for Sprays No. 4 and 5, and that the wood oils (pine oil and neutral oil) kill in proportion to the concentration, it will be noted that the expected kill of the two mixtures is as follows:

Ingredient	Percentage of Nymphs Killed by Ingredients Mixture A	Mixture B
Water	34	34
White oil (1%)	27	27
Wood oils	(Pine oil) 4	(Neutral oil) 5
Nicotine (1–2400)	24	24
Expected kill	89	90
Observed kill	90	85

All the plats had practically the same amount of foliage injury, which was light, so it is presumed that psylla feeding previous to treatment was responsible for the effect.

SERIES II. EXPERIMENTS WITH PENETROL

During the winter of 1928–29 this material was suggested to the writer for use against pear psylla. Considerable investigational work with Penetrol had been done previously by workers at other stations, so something was known of its safety to foliage when used with bordeaux and nicotine. Since it offered promise of reducing the cost of summer psylla sprays, a rather extensive test of the material was made in two pear orchards near Geneva in 1929. The results in only one orchard will be considered. In this series the spring application consisted of the following mixtures:

1. Bordeaux (2–40–100) and nicotine sulfate 1–800.
2. Bordeaux (2–40–100); Penetrol 1–200; nicotine sulfate 1–1067.
3. Bordeaux (2–40–100); Penetrol 1–200; nicotine sulfate 1–1600.
4. Bordeaux (2–40–100); Penetrol 1–200; nicotine sulfate 1–3200.

The plats were arranged according to the "chessboard" or "Latin square" system.[4] There were four replications of each mixture, making a total of 16 plats. This was done to compensate for variation in infestation. At the time of the summer applications a slight change was made: one set of plats was divided to allow a test of the mixture containing nicotine 1–800. Data was taken at the time of the summer application in the same manner as described for the first series. At the time of the spring application no counts were made previous to the treatment, but from 3 to 7 days after the spraying was done counts of live nymphs were made on all the plats and on the check plat. No "analytical" tests of Penetrol were made because the intensely hot, dry weather caused such a rapid transformation of the nymphs that the experiment had to be curtailed to secure dependable data.

The experiments of this series indicate that practical control of pear psylla may be secured with reduced nicotine content by the addition of Penetrol (½ per cent). Penetrol caused no foliage injury during the spring. Some foliage injury occurred on all the plats, including the regular spray, following the summer treatment, and was somewhat more serious on those trees on which Penetrol was used. The intensity of the injury was related to the number of psylla present previous to the spraying. The hot, dry weather was probably a factor

[4]It is planned to give an account of this arrangement in a later issue of this JOURNAL.

in producing these effects. However, until more is known regarding the susceptibility of pear foliage, it seems best to recommend this preparation for use only during the spring application when cooler weather normally occurs.

The results in one orchard are shown in Table 2.

TABLE 2. EFFICIENCY OF SPRAYS CONTAINING NICOTINE OR NICOTINE AND PENETROL ON PEAR PSYLLA

Mixture	Percentage Killed Spring Application Uncorrected	Summer Application Uncorrected	Summer Application Corrected
Bordeaux;* nicotine sulfate 1–800†	98.1	99	99
Bordeaux; Penetrol 1–200; nicotine sulfate 1–800‡	——	95	92
Bordeaux; Penetrol 1–200; nicotine sulfate 1–1067	99.9	99.6	99.6
Bordeaux; Penetrol 1–200; nicotine sulfate 1–1600	99.5	98	97.5
Bordeaux; Penetrol 1–200; nicotine sulfate 1–3200	98.8	96	95

*The bordeaux mixture used in all the tests consisted of copper sulfate 2 lbs.; hydrated lime 40 lbs.; water 100 gals.

†This is the regular foliage spray for pear psylla recommended in New York.

‡Dashing rain occurred before spray had dried.

CONCLUSIONS

A certain maximum kill of psylla nymphs appears to be secured with a small amount of nicotine. The minimum amount of nicotine necessary was not determined by the trials. Increasing the nicotine content above the maximum necessary either does not increase the toxicity of the spray or, at least does not seem to increase it in proportion to the amount used.

Derrisol (1–533), pine oil (1–100), and Hardwood neutral oil (1–100) seemed to have had about the same toxicity as free nicotine (1–3200).

Apparently, increase in effectiveness of a spray for psylla nymphs must be secured not by an increase of nicotine content but by the addition of other toxic substances that will not affect adversely the toxicity of nicotine.

The regular spray mixture consisting of bordeaux (2–40–100) and nicotine sulfate owes a part of its destructive capacity on psylla nymphs to the bordeaux and a part to dislodging of the insects by the pressure and volume of the spray.

It appears that the toxicity of the regular spray can be maintained or even increased by lowering the nicotine content, but at the same time adding other materials that are toxic to the insect but which do not react unfavorably on the nicotine. The experiments indicate that

Penetrol, white petroleum oils, pine oil, and Hardwood neutral oil produce these results when added to the regular spray. Of these, Penetrol and white oils have been the most extensively used on pear foliage.

Excepting Penetrol, whose specific toxicity toward psylla nymphs was not tested, the materials just listed, as well as bordeaux and nicotine, appear to add their specific toxicity to each other when mixed together except that mixtures of white oil and bordeaux do not give the full value of expected toxicity. This indicates that it may be possible to compound sprays for pear psylla nymphs by the addition of specific toxicity of ingredients provided incompatible substances are not included. For this reason the term "activator" of nicotine does not seem to be fitting for the ingredients "analyzed." Perhaps it would be better to say that they act by the principle of *summation*.

White oils appear to vary in killing power for psylla nymphs in direct proportion to the concentration. If used without other ingredients, they should generally be used at a 2.5 per cent concentration of oil to be effective in controlling the pest. If used at lower concentrations, their effectiveness can be fortified by the addition of nicotine or nicotine in pine oil or in Hardwood neutral oil.

Owing to the high specific toxicity of pyrethrum extract (M-P Insecticide 1–560) and Derrisol 1–533, in these tests it may be possible to compound these ingredients with other materials to secure economical mixtures that will be effective against psylla nymphs.

Pine oil (1 per cent) and Hardwood neutral oil (1 per cent) when added to the regular spray with reduced nicotine content, promise to give very good control.

The use of Penetrol (½ per cent) in the regular spray appears to make possible the use of a lower nicotine content.

Altho the results given above indicate that economies may be effected in psylla sprays, considerable additional experimentation is necessary before definite recommendations can be given regarding the best mixture to use, considering safety to foliage, toxicity to psylla nymphs, repellent effect on the adults, cost and convenience of application.

SOME NOTES ON DUSTING CUCUMBERS

By P. J. Chapman and G. E. Gould, *Virginia Truck Experiment Station*

Abstract

Preliminary tests made in 1929 show that cucumber plants dusted for control of cucumber beetles and downy mildew average smaller (yielded less in case of downy mildew) than those treated while dry. The dusts include: Hydrated Lime, Gypsum, these two with Calcium Arsenate, Sodium Fluosilicate, Calcium Fluosilicate, and "Copper-Lime."

Eight dusts were applied to cucumbers in 1929 to determine their efficiency in protecting this crop from the early attack of the cucumber beetles, *Diabrotica vittata* and 12-*punctata*. Another consideration, which proved to be the dominant one, was to measure the extent to which these materials inhibited plant growth. These, of course, are not new objectives. The present paper is merely a preliminary report on a somewhat different method of studying these apparently ubiquitous problems.

The arrangement of plats in the experimental field is illustrated in Table 1. There were twenty-two rows 555 feet long spaced five feet apart. The check area comprised the six middle rows and extended the entire length of the field. Treated plats were 1/55 of an acre, consisting of four rows, each 39.6 feet long. All dusts were represented in two, triplicated series. One series referred to as "wet" received treatments between 5 o'clock and 7 in the morning when the plants were moist with dew; the other, or the "dry" series, was dusted later in the morning after the dew had disappeared.

The seed was drilled in rows to conform to the commercial practice in this locality. Two thinnings were made. The first was on May 24, the earliest date we could be assured that all, or practically all, of the seedlings had come up or were visible. At this time the plants were carefully thinned to about 4 inches apart. A count made of the plants in all plats showed an excellent uniformity of stand throughout. The plats were thinned a second time on June 19 when the plants had begun to "vine." The plants removed were counted and weighed. A separate count and weight was taken of each 39.6 foot row or representing a total of 264 units. A crew of nine, including the writers, took these data in the field. All weights were recorded within three or four minutes after the plants had been pulled.

Treatments were made by the writers on the mornings of May 22, 27, 31, June 5, and 12. We used rotary hand dusters of the same make and model. A separate record was taken of the amount of dust applied to the individual plats at each dusting—a total of 240 weighings. There were naturally some differences in the amounts of the several mixtures applied due to differences in density and in physical properties. The variation in application rate for a particular dust, however, was slight. Gypsum, as is well known, is not easily blown from a dusting machine: it weighs about twice as much as an equal volume of hydrated lime. Calcium Fluosilicate ("Special" Extra Light, Victor Chemical Co.) was the lightest dust used, being about 20% less dense than hydrated lime. In its application, however, we invariably used more by weight than we did lime. An attempt was made to give all plants an equal

covering regardless of how much material was needed to accomplish this result. Less material appeared to "stick" to the plants in gypsum and

TABLE I

Average Weight of Plants in Grams Removed at Thinning

1W 26.4	1D 34.0	Ck 1 25.2	2D 25.1	2W 25.9
4D 22.3	4W 23.2	Ck 2 25.7	3W 27.3	3D 28.7
5W 29.0	5D 36.3	Ck 3 29.0	6D 23.6	6W 18.8
8D 26.7	8W 00.0	Ck 4 27.1	7W 31.2	7D 35.5
6D 32.4	6W 19.7	Ck 5 27.2	1W 32.8	1D 38.7
2D 35.5	2W 37.4	Ck 6 29.9	8D 28.9	8W 00.0
7D 33.5	7W 31.8	Ck 7 31.3	4D 33.7	4W 28.4
3D 38.7	3W 39.0	Ck 8 33.8	5D 35.5	5W 30.5
4D 30.6	4W 31.1	Ck 9 37.4	6W 25.5	6D 29.3
7W 38.5	7D 37.8	Ck 10 35.5	1W 31.8	1D 38.3
8W 00.0	D 36.3	Ck 11 40.0	5W 41.2	5D 49.5
2W 30.9	2D 39.2	Ck 12 36.0	3D 47.5	3W 41.0

Explanation

W dusts applied when plants wet with dew.

D dusts applied when plants dry.

1. Hydrated lime
2. Gypsum
3. Hyd. lime 20 lbs.
   Calcium arsenate 1 lb.
4. Gypsum 20 lbs.
   Calcium arsenate 1 lb.
5. Hydrated lime 18 lbs.
   Calcium casienate 2 lbs.
   Calcium arsenate 1 lb.
6. Monh. copper sulphate 15 lbs.
   Calcium arsenate 15 lbs.
   Hydrated lime 70 lbs.
7. Calcium fluosilcate
8. Sodium fluosilcate 1 lb.
   Hydrated lime 2 lbs.

calcium fluosilicate plats. More dust unquestionably adhered to the plants when they were moist, although the amount blown from the duster was in reality slightly less than in dry applications.

The application rate of the hydrated lime, copper-lime, and sodium fluosilicate products was approximately 30 pounds per acre. About 45 pounds was the acre-rate for calcium fluosilicate, and with gypsum our records show the rate to be 100 pounds, although the wastage in the application of gypsum with a dusting machine is large.

Our tables show, particularly No. 2C, that the plants treated when they were moist with dew averaged smaller, regardless of what dust was used. These differences range from sodium fluosilicate, where plants in the wet series were killed outright to gypsum and calcium fluosilicate plats where the differences have odds of less than 30 to 1, and therefore, from a statistical viewpoint, may not be considered significant.[1]

Since the wet and dry plats are paired (see Table 1) this also permits of a biometrical analysis by Student's method.[2] In this particular experiment, if Student's method is employed, we are forced to use only one-fourth of the variates included in the probable error treatment. One would expect that the reduction to three variates, in the case of Table 1 data, would rather obscure the true conditions. However, both methods agree on what is significant throughout except in the case of the copper-lime dust where three variates apparently were too few to bring out what the probable error concept with 12 variates has shown to be a distinctly significant difference.

USE OF COPPER-LIME DUSTS. An epiphytotic of cucurbit downy mildew, *Peronoplasmopara cubensis* (B & C) Clint. caused severe loss in this area in 1929. The presence of this disease was detected in the cucumber beetle plats on June 23, or at a time when the plants were still small (15 days before first picking). Our chances of procuring reliable yield data from the plats as they reflected the influence of cucumber beetle dusts did not appear bright, so we abandoned this objective and re-divided the field into seven plats with the object still of carrying out the idea of the effect of dusting dry and wet plants, but using in this case, of course, a fungicide.

Dustings for the control of the mildew were made with a traction machine, treating two rows at a time and going over these rows twice, driving in opposite directions. Three applications were made: June 27, July 3–4 and July 12–13. For the first dusting, a 15–15–70 monohydrated copper sulfate-calcium arsenate-hydrated lime dust was used, and for the other two a 20–80 mixture without the poison. The rate of

[1]Bessel's formula of computing probable error where variates are 12, "Gaussian's" with those of 24 or more.

[2]Student. Biometrika, *6*: 1–25, 1908. Ibid., 11: 414–417, 1917. Love and Brunson, Am. Soc. Agron. Jour., 16: 60–68. Ibid. Love, 16: 68–73.

TABLE 2. ANALYSIS OF WEIGHT DATA OF PLANTS REMOVED AT THINNING.

Part A. A Comparison of Wet and Dry Plats of All Dusts

Dust No.	Dusting Mixture	Condition of Plants	Number Weight Units	Number Plants	Mean Weight in Grams	Difference in Favor of "Dry" Plants	Odds That Difference is Significant
1	Hydrated Lime	Dry	12	852	37.3±1.08	6.6±1.64	142 to 1
		Wet	12	869	30.7±1.24		
2	Gypsum	Dry	12	834	34.9±1.45	4.8±1.76	13.6 to 1
		Wet	12	932	30.1±1.13		
3	Hyd. lime 20	Dry	12	913	37.2±2.01	1.9±2.43	Less than even
	Cal. ars. 1	Wet	12	913	35.3±1.36		
4	Gypsum 20	Dry	12	935	29.9±1.32	2.8±1.62	2.6 to 1
	Cal. ars. 1	Wet	12	992	27.1±0.95		
5	Hyd. lime 18	Dry	12	866	40.7±1.37	7.3±1.85	116 to 1
	Cal. casein. 2	Wet	12	835	33.4±1.25		
	Cal. ars. 1						
6	Hyd. lime 70	Dry	12	968	27.1±0.85	8.0±1.14	420,000 to 1
	Monoh. cop. sulfate 15	Wet	12	923	21.1±0.76		
	Cal. ars. 15						
7	Calcium fluosilic.	Dry	12	915	35.8±1.16	1.7±1.53	1.2 to 1
		Wet	12	848	34.1±1.01		
8	Hyd. lime 2	Dry	12	931	29.1±1.14		Infinite
	Sodium fluosilic. 1	Wet	12	0			
	Check		72	4944	31.7±0.56		

Part B. A Comparison of Wet and Dry Lime and Gypsum Dusts

Dust Numbers	Condition of Plants	Number Weight Units	Number Plants	Mean Weight in Grams	Difference in Favor of "Dry" Plants	Odds That Difference is Significant
1, 3, 5	Dry	36	2631	38.2±0.86	6.0±1.15	6714 to 1
	Wet	36	2617	32.2±0.70		
2, 4	Dry	24	1769	31.8±0.92	2.5±1.15	6.3 to 1
	Wet	24	1924	29.3±0.69		

Part C. A Comparison of All the Wets and Drys (Exclusive of Sodium Fluosilicate)

Dust Numbers	Condition of Plants	Number Weight Units	Number Plants	Mean Weight in Grams	Difference in Favor of "Dry" Plants	Odds That Difference is Significant
1, 2, 3, 4, 5, 6, 7	Dry	84	6283	34.6±0.59	3.9±0.79	825 to 1
	Wet	84	6312	30.7±0.54		

application was between 70 to 75 pounds per acre. These large amounts were purposely used because of the preliminary nature of the experiment, the purpose being to accentuate any differences that might be inherent and, since mildew spots were already present, it was decided that the test should not be invalidated by the possibilities of under-dosage.

TABLE 3. A COMPARISON OF DUSTING WET AND DRY PLANTS WITH COPPER-LIME FOR CONTROL OF DOWNY MILDEW

Plat	Condition of Plants When Dusted	Received Cucumber Beetle Dusts	Yield Weight (Lbs.)	Yield No. Primes	No. Culls
1	Dry	Yes	616.5	604	1244
2	Dry	Yes	619.5	608	1240
3	Wet	Yes	490.5	426	1126
4	Wet	Yes	444.5	357	989
5	Dry	No	532.0	419	1315
6	Wet	No	386.5	333	947
7*	Not Dusted	Yes	249.3	243	491

*Actual area about 45% of experimental field. Comparable data given.

DISCUSSION. We hope that this presentation of our preliminary tests and experimental methods will influence others, especially those in different climatic areas, to check our findings. Cucumber beetle damage was unimportant in 1929 as one may see from the data in Table 1 on untreated plats. The differences in size (weight) among the treated plats may be interpreted, therefore, as being due primarily to the reaction between plant and dust rather than the degree of protection these materials afforded against insect attack. Plants treated with gypsum, either wet or dry, averaged smaller than plants receiving hydrated lime while dry. This point surprised us in view of the superior results workers in other areas have had with gypsum.

The differences in plant-weight between those treated wet and dry is probably attributable to several causes none of which may be truly analyzed from these data. It is, of course, apparent that more material adhered to plants dusted while wet. And, unless toxic materials are put into solution, as was probably the case with sodium fluosilicate, the generally smaller size of "wet" plants may be due simply to the degree that metabolic activities are interfered with, a condition that would normally result from the presence of any finely divided foreign matter.

HYDRATED LIME IN SUMMER SPRAYS FOR THE CONTROL OF THE ORIENTAL FRUIT MOTH, A SECOND REPORT

By L. A. STEARNS and R. B. NEISWANDER

(Withdrawn for publication elsewhere)

WORK DONE ON THE PARASITE, *MACROCENTRUS ANCYLIVORA*, AT THE ORIENTAL PEACH MOTH LABORATORY AT MOORESTOWN, NEW JERSEY, DURING 1929

By H. W. ALLEN, *Moorestown, N. J.*

(Withdrawn from publication)

ORIENTAL PEACH MOTH CONTROL STUDIES IN 1929

By PHILIP GARMAN

ABSTRACT

Field experiments in control of the Oriental peach moth, *Laspeyresia molesta*, in 1929 showed no control for talc dust and slight reductions for lime and oil combinations. Laboratory ovicide experiments under insectary conditions showed good kill for oil preparations, particularly oil and pine oil combinations.

During the past season we conducted experiments in field and laboratory in the control of the Oriental peach moth, *Laspeyresia molesta*. In our field experiments, a four-acre orchard near our Mt. Carmel farm was leased and in addition a smaller plot of the same variety was used on the Station farm, this being about one-fourth mile from the other. Some of the treatments were begun in June and repeated every ten days until August; others were begun in August and repeated at weekly intervals until harvest. Our results are shown in some detail in the following table:

TABLE 1.

Treatment	Total Fruits	Per cent Infested	Average per cent Infested
Talc dust	188	40	
	287	33	
(1)	315	37	28.2
	304	24	
	308	25	
Lime	86	34	
	146	22	
(2)	255	27	19.9
	455	21	
	627	13	
White oil emul., Pyrethrum soap	81	27	
	87	19	
(3)	104	24	19.5
	117	11	
	146	18	
White oil emul., Nicotine sulphate	77	9	
	100	9	
(4)	181	14	16.0
	187	23	
	223	17	
Check	63	28	
	85	25	
	175	16	
(5)	227	34	22.2
	247	28	
	285	18	
	338	14	

In addition to the treatments given in the table, eight large Elberta (Plot 6) trees in a block of 20 were sprayed with white oil emulsion at .83 per cent oil content without additions. Two trees from treated and check lots were counted with the result that seven per cent of those treated were injured; whereas, 20 per cent of the untreated were found to be infested. Thus, in two out of three experiments using white oil emulsions, there was considerable reduction in injury by the Oriental peach moth.

The experiments mentioned consisted of four sprays and one dust, the dates of the various applications and their concentration and dosage being as follows. A power spray was used, furnishing 200 pounds, the trees sprayed from the ground with rods and nozzles.

Material	Amount per 100 Gallons	Dosage per tree	Dates of Treatments
1. Talc	——	2–3 lbs.	June 7, 17, 28, July 8, 18, 31, Aug. 9, 16, 23, 30.
2. Lime (Masons hydrated)	40 pounds	2–4 gals.	June 7, 18, 28, July 8, 18.
3. White oil emul.[1] Pyrethrum soap	1 gal. (.83% oil) 1.25 pints	2–4 gals.	July 31, Aug. 9, 16, 23, 30.
4. White oil emul.[2] Nicotine sulphate	1.5 gals. (1.2% oil) 1 pint	2–4 gals.	July 31, Aug. 9, 16, 23, 30.
5. White oil emul.[1]	1 gal. (.83% oil)	8 gals.	July 31, Aug. 9, 16, 23, 30.

[1]Heavy oil; Viscosity 108 Saybolt.
[2]Light oil; Viscosity 50 Saybolt.

Counts were made from split fruits only, all dropped and picked fruits from five or more trees being considered. The trees selected had varying amounts of fruit and it will be seen that there is a considerable increase in infested fruit as the number of fruits per tree decreases. There are, of course, some deviations (Plot 4 especially) from this trend but for the most part the greater amount of fruit per tree, the smaller the infestation. Complete counts are therefore given. Our results with hydrated lime and talc dust were disappointing, there being slight or no increase of sound fruit in these plots. The oils showed more promise, but there is not enough difference here to justify their recommendation at present and their cost is prohibitive. The season of 1929 was a dry one in Connecticut and results obtained this year should be optimum for most materials. Rainy seasons would doubtless influence the amount of control, and might eliminate any differences obtained this year.

No injury was seen on any of the trees although they were carefully examined from time to time. There was some spotting of the fruit, however, from the last oil spray in one of our plots, while considerable white wash and talc remained at harvest in plots treated with these

materials. The trees sprayed with lime were noticeably free of spray injury although no particular stimulation could be seen on comparison with untreated trees.

Laboratory work with ovicides consisted of testing various oils and combinations in order to explain if possible our field results. Eggs were sprayed uniformly, using the same nozzle, the peach leaves containing the eggs being then pinned on a rack in an open insectary and left until the eggs in the check lots had hatched. No check counts are given in the table since none averaged over 10 per cent mortality in any of the lots. The following results were obtained:

TABLE 2.

Materials Used	Dilution	Emulsifier	No. of Tests	No. Eggs	Per cent Killed
White oil Pyrethrum soap	.83% .16%	Ammon+ Caseinate	8	973	92.1
White oil Nic. sulphate	.83% .16%	"	3	267	89.8
White oil	.83%	"	10	1104	86.8
White oil	1.00%	Milk[1]	10	1173	94.9
White oil Pine oil[2]	.80% .20%	Soap	2	141	98.0
White oil Pine oil[2]	.80% .20%	Milk	1	79	95.0

[1]1 gr. milk, 1 gram oil–100 cc water.
[2]Steam distilled.

The increase from additions of pyrethrum soap and nicotine over the same oil and same emulsifier at the same dilution is seen to be slight. Combinations with pine oil gave good results in the few tests that were conducted with this material while pure one per cent white oil, emulsified with powdered skim milk gave almost as good results as can be expected from any material. The increase of three per cent kill with added nicotine sulphate and six per cent with pyrethrum soap did not show in our 1929 field experiments. It is doubtful whether as a strict ovicide such combinations have much advantage over pure oil emulsions.

EXPERIMENTS AGAINST WINTERING LARVAE OF THE ORIENTAL PEACH MOTH, *LASPEYRESIA MOLESTA* BUSCK

By J. WILLIAM LIPP, *Assistant Entomologist, Deciduous Fruit Insect Investigations, Bureau of Entomology, U. S. Department of Agriculture*

ABSTRACTS

During the dormant seasons of 1927–28 and 1928–29 the writer conducted tests against wintering Oriental peach moth larvae. The larvae were permitted to make hibernacula on sticks cut from pear limbs. The sticks containing the larvae were hung in an outdoor cage. Toxicity was determined by the number of moths emerging from sprayed and unsprayed sticks. Late fall spraying and early spring spraying

produced approximately the same results. Examination of the sticks prior to emergence did not prove a satisfactory way of determining mortality. Loss of the larvae through natural mortality and the appearance of fungus were very evident on the unsprayed sticks. These variations made comparisons exceedingly difficult. None of the solutions tested gave a mortality greater than that of 67 per cent.

The reaction of overwintering larvae of the Oriental peach moth to paradichlorobenzene (applied for the control of the peach tree borer)[1] suggested the possibility of finding a practical dormant spray which would materially decrease the size of the spring brood of moths. This possibility was also suggested by Stearns[2] as a result of studies of the location of overwintering larvae. These tests were conducted during the dormant seasons of 1927–28 and 1928–29 at Moorestown, New Jersey.

Pear limbs with rough bark were cleared of the smaller branches and sawed into sticks approximately seven inches in length and from one to two inches in diameter. Into one end of each stick was fastened a large screw-eye. Four sticks were placed horizontally in a pan, and 100 larvae, which were ready to spin cocoons, were introduced. The sticks were changed to a vertical position after the larvae had started to spin on them. When all the larvae had spun cocoons the sticks were hung on nails in an outdoor cage, where they remained all winter.

Four sticks containing 100 larvae were used as a unit when being sprayed. They were thoroughly drenched with solutions applied from a hand sprayer and were then replaced in the screened cage. Just prior to the emergence of the moths (as indicated by the development of wintering material kept in the insectary) each unit of sticks was placed in a small cage, and observations were made on the number of moths which emerged.

All spraying was done on clear mornings when the atmospheric temperature was above 32 degrees F. Most of the solutions were applied in February and March, although some were applied in November to determine, if possible, the comparative value of late fall and early spring applications. In some cases two units of larvae were sprayed with the same solution; one unit being examined for larval mortality about two weeks later, and the other being kept for observation on moth emergence, to obtain comparative data on the two methods of determining mortality.

Although approximately 100 tests were made during the two seasons, it was impossible to compare the solutions under all different condi-

[1]Peterson, Alvah. 1923. The Peach Tree Borer in New Jersey. New Jersey Agricultural Experiment Station Bulletin No. 391.

[2]Stearns, L. A. 1927. Hibernation Quarters of *Laspeyresia molesta* Busck. JOURNAL OF ECONOMIC ENTOMOLOGY. Vol. 20 (1):185–189.

tions. The figures given below indicate the percentage of emergence from treated units as compared with the emergence from the untreated units. Thus, if only 50 per cent of the untreated individuals emerged, the emergence of 30 per cent of the individuals from a treated unit would be recorded "60 per cent emergence" as compared with the emergence from the untreated unit. The materials which decreased the emergence to 60 per cent or less of the check emergence are as follows:

Material	Per cent Emergence
10 per cent Nitrobenzene (mono)[3]	33
5 per cent Potassium ethyl xanthate	34
5 per cent Linseed oil (raw)[3]	39
5 per cent Wormseed oil[3]	43
5 per cent Tar acid oil[3]	44
5 per cent Potassium ethyl xanthate	44
5 per cent Nitrobenzene (mono)[3]	46
10 per cent Tetrachlorethane[3]	46
5 per cent Dippel's oil plus 2 per cent Nitrobenzene[3]	52
2 per cent Sodium alginate	55
5 per cent Linseed oil (boiled)[3]	55
5 per cent Nitrobenzene (mono)[3]	60

The following showed little or no effectiveness at five per cent concentration: ammonium sulfide (yellow); benzene[3]; carbon tetrachloride[3]; calcium cyanide (dust); cod liver oil;[3] China wood (Tung) oil;[3] Dippel's oil, plus one per cent wormseed oil;[3] fish oil[3]; formaldehyde; furfural; gum arabic; kerosene;[3] lime-sulfur; boiled linseed oil[3] plus any one of the following—one per cent paradichlorobenzene, one per cent rosin; one per cent Dippel's oil, one per cent nitrobenzene, one per cent thiocarbanilide, one per cent betanaphthol, one per cent gum damar; oil of tar[3] plus one per cent nitrobenzene or one per cent wormseed oil; orthodichlorbenzene (commercial[4]);[3] perilla oil[3]; poppyseed oil[3]; potassium dichromate; sodium ethyl xanthate; sodium hypochlorite; sodium thiosulfate.

The comparative effectiveness of the various solutions was exceedingly difficult to determine because of the high percentage of mortality in the untreated larvae, which ranged from 22 per cent to 75 per cent in different units, and which in many cases exceeded that of the sprayed larvae. Since the infestation of the sticks had been made at different times over a six-week period, it seemed only fair to compare the mortality in each unit with the mortality in the check unit which had been prepared at approximately the same time.

[3]These figures indicate emulsions using sodium oleate as the emulsifier.

[4]Lipp, J. William. 1929. The Purity of Commercial Orthodichlorobenzene. Journal of Economic Entomology. Vol. 22 (1):268.

One striking condition noted at the time of the emergence of the moths was the large number of dead larvae covered with fungus on the untreated sticks. Whether the fungus developed on the larvae after their death, or whether it was the cause of death is not known. In contrast to this, practically all the spray solutions had some fungicidal effect, since very little fungus appeared on the sprayed sticks, with the exception of those treated with sodium alginate, sodium resinate, or sodium silicate. Its presence on these sticks suggest that the alkalinity of the solutions may have been a factor in the development of the fungus.

Sprays applied in early spring caused a somewhat greater mortality than similar sprays applied in the late fall. The difference in mortality, however, was not marked.

Attempts to determine mortality by examining the sticks for dead larvae proved impractical. Compounds which, like linseed oil and sodium alginate, were applied with the idea of their hardening the cocoons and making emergence more difficult had no effect on the larvae. Furthermore, compounds which, like carbon tetrachloride and nitrobenzene, were applied with the idea of their penetrating the cocoons, showed little action on the larvae during the relatively short period between their application and the examination of the sticks. Undoubtedly, the low temperature prevalent at this time caused a very slow volatilization of the chemicals, and as a result the fumigation effect was rendered ineffective or, at least, incomplete. An examination of a unit treated with potassium ethyl xanthate, for example, showed 72 larvae alive, but of these 30 were in a weakened condition, which indicated that the chemical had had some effect. It is quite possible that these sick larvae would have been dead if the sticks had been examined one week later.

Some idea of the variations encountered will be seen in the following examples: The addition of sodium oleate increased the toxicity of acetone and decreased that of pyridine; one application of five per cent Dippel's oil gave a relative mortality of 49 per cent while in another test with the same material the emergence from the sprayed sticks exceeded that from the unsprayed; three tests with five per cent wormseed oil gave 23, 57, and 0 percentage mortality.

A number of similar examples might also be given but the writer feels that they would be unnecessary. It is apparent that the results obtained do not give much encouragement to the idea of controlling the Oriental peach moth by means of a dormant spray, but it is hoped that they will be of interest, if not of value, to investigators interested in dormant sprays for other insects.

RECENT EXPERIMENTS ON ORIENTAL PEACH MOTH CONTROL IN NEW JERSEY[1]

By BYRLEY F. DRIGGERS, Ph.D., *Associate Entomologist, New Jersey Agricultural Experiment Station*

ABSTRACT

Nicotine sulfate and white oil emulsions failed to control the Oriental Peach Moth, *Laspeyresia molesta*, when these sprays were used against the first brood eggs and larvae. Two years spraying tests with pyrethrum impregnated white oil emulsions used at one per cent or less failed to control the Oriental Peach Moth when these sprays were applied to coincide with the appearance of third brood eggs and larvae. Talc dust applied at the time the third brood eggs were hatching gave a partial control of the peach moth in two orchards. In a third orchard the talc dust was found to prevent the work of the egg parasite, *Trichogramma minutum* and no control was obtained. Experiments in 1928 and 1929 showed that larval parasitism by *Macrocentrus ancylivora* could be increased in young orchards in North Jersey by the liberation of this parasite during June, July and August.

The Oriental Peach Moth (*Laspeyresia molesta* Busck) has been in New Jersey about 12 years. The summer of 1923 witnessed a severe outbreak of the peach moth, particularly in the latter part of the summer where in some orchards infestations of 90 per cent of the fruit were recorded. Following 1923 a progressive decline in the amount of damage done by the peach moth was observed, a low level being reached in 1927. The decrease in the amount of damage by the peach moth from 1924 to 1927 was due in a large measure to the work of parasites and was particularly noticeable in the orchards of South Jersey.

The season of 1928 showed an apparent upward swing in fruit infestation from the season of 1927. The trend during 1929 was still upward and was more noticeable than in the season of 1928. Whether the 1929 infestation will establish a new peak of infestation and be followed by a decline in 1930, or whether the 1930 infestation will mount still higher, are questions that cannot be answered at this time.

STATUS OF SUPPLEMENTARY CONTROL MEASURES. The recommendations in New Jersey concerning the effectiveness of the plowing under of mummies and trash in the spring, P-C Benzine treatment for the peach borer, the destroying of culls and drops and the isolation of picking baskets, in reducing the number of larvae that overwinter successfully, still hold. What work has been done along these lines in the past several seasons confirms the work of previous seasons. A complete clean up of the larvae on the ground by thorough cultivation and

[1]Paper of the Journal Series, New Jersey Agricultural Experiment Station, Department of Entomology.

of the larvae around the base of the tree by P-C Benzine, would not free an orchard of larvae entirely. Experiments carried on at the New Jersey Agricultural Experiment Station during 1926 and 1927 showed that a substantial percentage of the larvae overwinter in and on the rough bark in the upper part of the tree. No winter wash has been discovered or reported upon that will clean up these larvae without injuring the tree.

Bait pans as a method of control for the peach moth have been tested extensively at New Jersey and other experiment stations. With the baits that have been tested to date, this method has proven of little or no value as a control. The writer has found bait pans are a help in determining when the emergence of a given brood of moths is well under way.

Status of Summer Control Measures. Experiments carried on at the New Jersey and other experiment stations previous to 1927 had shown that nicotine sulfate added to the regular peach spray schedule, plus certain additional applications of nicotine sulfate and soap, gave a partial control of the peach moth. The increase in clean fruit from the use of nicotine sulfate was found to return a substantial profit over and above the cost of materials and labor, therefore nicotine sulfate is being recommended for the peach moth in the spray schedule for peaches. However these recommendations of nicotine sulfate for the peach moth had certain objections chief of which were (1) the high cost of nicotine sulfate, (2) only a partial control could be expected with the treatment and (3) the time and labor involved in the extra applications. For these reasons experiments have been continued to develop a cheaper and more effective treatment for the peach moth.

Experiments with White Oil and Nicotine Sulfate. In 1927 an effort was made to control the peach moth by frequent applications of sprays during the time the first brood eggs were being deposited. Nicotine sulfate and a white oil emulsion were tested separately. Previous experiments had shown that these two materials were more effective in killing the eggs and larvae than any other spray that had been tried. Although a considerable reduction of first brood twig injury was apparent in both the nicotine sprayed orchard and oil sprayed orchard, a complete clean up of the first brood was not obtained with either material. Subsequent fruit counts in the nicotine sulfate sprayed orchard showed approximately 21 per cent of the fruit injured. This percentage of injury was about the same as was found in this orchard the previous year.

In 1928 a block of trees in each of two Elberta orchards were sprayed with a pyrethrum impregnated oil at weekly or ten day intervals during August in an effort to control the peach moth by killing the eggs and larvae of the late broods. Previous laboratory experiments had shown that such a spray used at 0.5 per cent actual oil would kill approximately 90 per cent of the eggs and larvae. Fruit counts made at the end of the season showed no reduction in fruit infestation in one of the tests and only a slight reduction (13 per cent) in the other.

From the results obtained in 1928 it was thought that a one-half per cent oil spray was not sufficient to maintain an oil film on the fruit and foliage. Therefore the experiment was repeated this past season using one per cent actual oil. When the fruit counts were made at the end of the season again only a slight reduction (less than the year before) was apparent from the use of the oil.

The negative results obtained in the oil spray tests were rather puzzling and at first no logical explanation for the lack of control presented itself. However experiments carried on in a different material (which will be discussed presently) indicate that possibly the oil spray was killing certain of the peach moth parasites equally as well or better than it was killing the eggs and larvae of the peach moth. Therefore any kill of the eggs or larvae by the oil was nullified by the failure of the parasites to account for their share of the reduction. At the same time the parasites were free to effect their normal amount of reduction of eggs and larvae in the check block.

Experiments with Talc. In the late summer of 1928 a number of dusts were tested in the insectary with the view of developing a material that would act as a barrier to the newly hatched larvae. Finely ground talc and mica dusts proved the most effective in killing the young larvae in the insectary tests and in the small preliminary field tests. Since talc is cheaper and sticks to the foliage better than mica, it was planned to give the talc a thorough test in the field during the season of 1929. Accordingly dust blocks were run in two Elberta and one Fox Seedling orchard. Talc dusting on the three blocks was begun the last week in July and continued through August. An effort was made to maintain a loose coating of the dust on the foliage throughout the period. As this necessitated redusting after rains a total of nine applications were made in each of the three orchards. The amount of reduction in fruit infestation obtained in the dust block in the three orchards is set forth in Table 1.

TABLE 1. RESULTS OBTAINED FROM LATE SEASON TALC DUSTING IN A FOX SEEDLING AND TWO ELBERTA PEACH ORCHARDS

Orchard Number	Variety	Treatment	No. Trees	Fruit Examined	% Fruit Infested Visible	Invisible	Total
1	Fox seedling	Check	5	1900	32.2	15.3	47.5
		Dusted	5	1304	14.3	13.8	28.1
2	Elberta	Check	5	4094	43.6	36.2	79.8
		Dusted	5	5276	26.0	26.8	52.8
3	Elberta	Check	10	10280	34.1	23.6	57.7
		Dusted	7	5267	29.1	27.3	56.3

The data in Table 1 show that in the Fox Seedling orchard the infestation was reduced from 47.5 per cent on the check to 28.1 per cent on the dusted block, a reduction of approximately 40 per cent. In the first Elberta orchard the infestation was reduced from 79.8 per cent to 52.8 per cent, a reduction of 33.8 per cent. In the second Elberta orchard only a slight reduction was obtained.

On August 20 the writer made an examination of the fruit in both the check and dusted blocks in orchard three of Table 1. It was apparent that considerable new larval entry was taking place in the fruit in both the undusted and dusted blocks. In order to get at definite figures one-third of the fruit on each of ten trees (five in the check block and five in the dust block) was picked and the percentage showing visible entry determined. Thirty-six per cent of the fruit from the check block showed injury while 18 per cent was similarly infested on the dust block. These figures showed that the dust had reduced entry approximately 50 per cent up to August 20. Nevertheless, the 18 per cent injury in the dust block showed that a considerable number of the larvae were reaching the fruit in spite of the dust. In searching for an explanation for the fact that the dust was failing to stop the young larvae more effectively, the writer considered the possibility of the dust killing or interfering with the work of some of the parasites. It was known that the egg parasite, *Trichogramma minutum*, frequently parasitized a high percentage of the peach moth eggs at that time of the year.

In order to determine whether the dust was interfering with the work of the egg parasites, the writer obtained eggs from breeding cages in the insectary and "planted" them in the foliage of trees in both the check and dusted blocks. Four different "plantings" were made and a total of 661 eggs used. The data set forth in Table 2 show the dates the eggs were placed in the orchard, dates removed from the orchard and the percentage of twigs and eggs that showed *Trichogramma* parasitism.

TABLE 2. PERCENTAGE OF ORIENTAL PEACH MOTH EGGS PARASITIZED BY *Trichogramma* SP. WHEN EGGS WERE PLACED IN TALC DUSTED AND UNDUSTED TREES.

Lot No.	Block	Date Placed	Date Removed	Total Twigs in Lot	No. Twigs Parasitized	Total Eggs in Lot	Parasitized Eggs No.	Parasitized Eggs Per cent
1	Check	8/17	8/22	11	9	197	106	54.0
2	"	8/22	8/26	11	9	76	40	52.0
3	"	8/27	8/30	5	2	53	15	28.3
4	"	8/28	8/31	5	1	36	6	16.6
5	Dust	8/17	8/22	6	0	135	0	0.0
6	"	8/22	8/26	11	0	98	0	0.0
7	"	8/27	8/30	4	0	42	0	0.0
8	"	8/28	8/31	5	1	24	1	4.2
		Totals	Check	32	21	362	167	46.1
			Dust	26	1	299	1	0.3

An examination of the data in Table 2 will show that 46.1 per cent of the eggs placed in the check block were parasitized. Only one of the three hundred eggs placed in the dusted block showed parasitism. It appears from these results, and from the fruit examinations in this orchard at the end of the season, that any effectiveness the dust had in stopping the larvae was nullified by the fact that the dust also interfered with the work of the parasites.

WORK WITH PARASITES. Studies of parasitism of Oriental Peach Moth larvae in twigs in different sections of New Jersey over a period of three years had shown that *Macrocentrus ancylivora* Roh. was responsible for most of the parasitism in South Jersey. At the same time *Glypta rufiscutellaris* Cress. was found to be the principal parasite in North Jersey. The possibility of utilizing each of these parasites in that part of the state where it was not very abundant was given attention in 1928 and 1929.

Oriental Peach Moth larvae were collected from twigs in South Jersey in the early part of the summer of 1928. From these larvae were reared adults of *Macrocentrus ancylivora* Roh. The first of these parasites emerged July 1 and were liberated in a young peach orchard at the college farm at New Brunswick. From that date to September 20 a total of 175 female and 152 male *M. ancylivora* were liberated in this orchard. In order to determine what effect the liberation of these parasites would have on the peach moth larvae, the writer made weekly collections of larvae from twigs in the liberation orchard. Collections were made on the same dates in two other orchards where no *M. ancylivora* were liberated in order to check the results. Weekly collections in the three orchards were begun May 29 and continued to September 11. The detailed results are set forth in Table 3.

TABLE 3. PERCENTAGE OF ORIENTAL PEACH MOTH LARVAE PARASITIZED BY *Macrocentrus ancylivora* Roh. IN CHECK ORCHARDS "A" AND "B" AND LIBERATION ORCHARD "C"

Date of Collection	% Parasitism by *M. ancylivora* "A"	"B"	"C"	No. *M. ancylivora* Liberated in "C"
May 29	0.0	0.0	0.0	0
June 5	0.0	0.0	0.0	0
12	0.0	0.0	0.0	0
19	0.0	4.7	0.0	0
26	0.0	6.2	0.0	0
July 3	0.0	0.0	0.0	29
7	0.0	0.0	3.8	45
10	3.2	0.0	18.0	2
17	0.0	0.0	12.2	0.0
24	0.0	0.0	5.4	2
31	0.0	0.0	0.0	40
Aug. 7	2.9	0.0	15.6	137
11	11.1	10.8	24.8	14
14	0.0	2.9	32.6	0
21	0.0	7.3	12.8	0
28	16.6	10.0	16.5	0
Sept. 4	0.0	30.0	0.0	45
11	0.0	20.0	33.3	13

An examination of the data set forth in Table 3 will show that there was a material increase in the parasitism of the larvae by *M. ancylivora* in orchard "C" where this parasite was liberated. This increase is found in the collections following the dates of liberation. The total figures on *M. ancylivora* parasitism in the three orchards for the entire season was 1.3, 4.4 and 14.2 per cent respectively for orchards "A", "B" and "C."

TABLE 4. PERCENTAGE OF ORIENTAL PEACH MOTH LARVAE PARASITIZED BY *Macrocentrus ancylivora* Roh. IN CHECK ORCHARDS "A," "B" AND "C" AND LIBERATION ORCHARD "D"

Date of Collection	% Parasitism by *M. ancylivora* "A"	"B"	"C"	"D"	No. *M. ancylivora* Liberated in "D"
May 22	0.0	0.0	0.0	0.0	0
30	0.0	0.0	0.0	2.9	0
June 6	0.0	0.0	6.9	2.8	0
13	0.0	0.0	16.6	2.3	0
20	0.0	0.0	0.0	9.3	85
27	8.3	0.0	2.8	36.7	57
July 3	0.0	0.0	10.9	44.1	0
10	0.0	0.0	5.2	21.6	0
17	0.0	0.0	1.9	0.0	89
24	0.0	7.3	2.6	56.1	148
31	23.3	51.0	5.5	86.4	125
Aug. 7	50.0	30.6	22.2	80.0	0
15	0.0	20.8	9.5	27.7	48
21	0.0	16.2	0.0	42.9	26
28	0.0	0.0	0.0	0.0	0
Sept. 4	0.0	33.3	0.0	100.0	0

The liberation experiments were repeated during the summer of 1929. This time weekly collections of larvae were begun on May 22 in four

orchards at the college farm and the collections continued into September. These four orchards, which for convenience we will call "A," "B," "C" and "D," were all within a quarter of a mile of each other. Orchards "A" and "C" were the same orchards as were used the previous year. Orchards "B" and "D" were young orchards set out in the spring of 1929. The results from the 1929 liberations are set forth in Table 4.

An examination of the data in Table 4 will show that there was a marked increase in the percentages of parasitism in orchard "D," where *M. ancylivora* was liberated, over the three check orchards. In orchard "C," which, it will be recalled, was the liberation orchard in 1928, the percentages of parasitism indicate that there was some carry over from the built up parasitism of 1928. There was practically no *M. ancylivora* parasitism in orchards "A" and "B" in May, June and the first half of July. The appearance of a considerable number of *M. ancylivora* in these two orchards the last of July and August may have been due to a drift from the liberation orchard "D". It may be noted that the high percentage of parasitism in the liberation orchard "D" came on collection dates following the two periods when the maximum number of *M. ancylivora* were liberated. The total *M. ancylivora* parasitism for the season was 3.3, 12.8, 5.3 and 34.1 percentages for "A," "B," "C" and "D" respectively.

ORIENTAL PEACH MOTH PARASITE WORK IN NEW YORK

By Derrill M. Daniel, *Experiment Station, Geneva, N. Y.*

Abstract

Results are given of two years experiments in colonizing *Macrocentrus ancylivora* Roh. in the area of new infestation of the oriental peach moth (*Laspeyresia molesta* Busck) in western New York. The parasite has apparently established itself in this region. *Glypta rufiscutellaris* Cress. and *Ascogaster carpocapsae* Vier. were found to parasitise the peach moth in western New York in 1927, altho the percentage of parasitism was negligible. In 1928 *Glypta* parasitised 12 per cent of the larvae of the peach moth and in 1929 only 0.71 per cent. In both of these years *Ascogaster* was of rare occurrence. In 1929 twig collections from the Hudson Valley and Long Island showed a parasitism by *Macrocentrus* of 51 and 89 per cent respectively. Seven hundred thousand *Trichogramma minutum* Riley liberated in one orchard parasitised 36 per cent of the season's eggs.

The oriental peach moth (*Laspeyresia molesta* Busck) made its first appearance in western New York in a few orchards in the Lake Erie Valley near the Pennsylvania line in 1926. During the season of 1927 collections of infested twigs in this area were made to determine the extent of parasitism and the species present. These collections showed a negligible amount of parasitism. Only a few specimens of two species, *Ascogaster carpocapsae* and *Glypta rufiscutellaris*, were obtained.

In the late summer of 1927 the peach moth was found to be infesting several orchards in Niagara county. Since this county is much more productive of peaches and because the infestation by the peach moth was heavier, the work was transferred to Niagara in 1928. The pest has continued to spread eastward, making its appearance in all peach orchards in the county this past season. New points of infestation have been found thruout almost the whole of western New York. The peach moth is therefore well established in this area and indications are that injury will continue to increase in this important peach producing section.

In view of the continued inability of insecticides to give satisfactory control economically, the concensus of opinion is that the use of parasites is the most hopeful method for keeping the insect below the economic minimum. Therefore, efforts looking toward the control of the peach moth in New York have been concerned almost exclusively with the transfer, breeding and distribution of promising parasitic species.

Macrocentrus ancylivora Roh. was generally conceded to be the most promising of the fifty or more species attacking the oriental peach moth. The first attempt of the colonization of this species was made by Dr. Stearns in 1927 while in Ohio. However, it was later discovered to be already present and importations were discontinued. Therefore, in order to determine the possibility of establishing this parasite in a new area of infestation, importations were made from southern New Jersey.

A report has already been made on the method of this transfer.[1] A total of eleven hundred *Macrocentrus* were liberated in two Niagara orchards during the first week of July. Twig collections made in these orchards before liberation showed no parasitism at all. Subsequent collections were made at approximately weekly intervals during the remainder of the season. An average of the parasitism in these orchards showed 8.15 per cent due to *Macrocentrus ancylivora* and 12.54 per cent due to *Glypta rufiscutellaris*. *Glypta* emerged only from collections made during the latter part of the season. Two orchards used as checks showed the presence of no *Macrocentrus* but 23.68 per cent parasitism by *Glypta*. In the area immediately adjacent to the Niagara River approximately 15 per cent of the fruit was infested by the peach moth in 1928.

During the season of 1929 importations of *Macrocentrus* from New Jersey were continued. A total of fourteen hundred were liberated in six orchards in Niagara and two orchards in Chautauqua county.

[1]Technique Employed in Transferring Parasites of the Oriental Peach Moth (*Laspeyresia molesta* Busck), Derrill M. Daniel. Jour. Econ. Ent. Vol. 22, pp. 801-805. Oct. 1929.

Twig collections made before distribution of parasites showed *Macrocentrus* to be present in the two orchards which received liberations the previous year and in one nearby orchard. Liberations were made during the last week of June and the first two weeks of July. Twig collections made thruout the summer showed a parasitism by *Macrocentrus* of 13.79 per cent. Collections made in the latter part of the season from all the remaining orchards along the Niagara River showed the presence of *Macrocentrus* in each of them. Infested twigs were as abundant on September 5th as at any time during the season. Collections made at that time showed parasitism to be as high or higher than at any other time. This indicates the possibility of a high percentage of hibernating larvae having become parasitised. In this area approximately 60 per cent of the fruit was infested by the peach moth.

In Chautauqua county a parasitism by *Macrocentrus* of 29 per cent was obtained in the two orchards which received parasites. However, the peach moth infestation dropped rapidly in late July because of lack of suitable food. The twigs hardened prematurely due to drought and there was no fruit. During August it was almost impossible to find infested twigs. It is believed that this shortage of host material will practically wipe out the liberations of parasites made there this season.

Glypta was conspicuous by its absence this past year. An average of only 0.71 per cent parasitism by this species was obtained from all collections during the summer. *Ascogaster* was of rare occurrence during all three years.

Liberations of *Trichogramma minutum* Riley totalling seven hundred thousand individuals were made in one orchard in Niagara county. Egg counts made during the season showed 36 per cent of the eggs to have been parasitised. Like counts in a check orchard showed 4 per cent of the eggs parasitised.

Twig collections made in the Hudson Valley on July 30th and 31st showed 51.53 per cent parasitism. Collections made on Long Island in the vicinity of Riverhead and Southold showed 89.19 per cent parasitism. In both of these *Macrocentrus* constituted at least 98 per cent of the species represented. No liberations had been made in this area, so that the figures represent natural parasitism.

Friday Morning, November 22, 1929

BEES FOR THE ORCHARD

By E. F. Phillips, *Cornell University, Ithaca, New York*

Abstract

The requirements for colony strength in order to have bees which will give good service in pollination of fruit is emphasized. The danger to bees from dusting of poisonous materials is discussed.

The demand for honeybees for use in bringing about cross pollination of fruits is increasing and will still further increase. Clean cultivation, intense regional specialization and other less tangible causes are reducing the number per acre of fruit of individuals of wild species capable of serving the orchardist, and this reduction in some places has reached a point where the natural supply of pollinating agents in an average year is inadequate to set a profitable fruit crop. It is not proposed to discuss problems arising from the need of pollinating varieties and other horticultural problems or the factors reducing wild species but rather to mention some problems connected with beekeeping and entomology which arise from the need of pollinating agents. Some of the beekeeping advice that has been given regarding this problem seems seriously erroneous, and it is hoped to correct this in part.

The greatest menace to the use of honeybees in orchards in many fruit areas is the prevalence of dusting with poisonous materials. Spraying with whatever material used is rarely seriously damaging to bees unless applied right at the time of blossoming, which is rarely advised or practiced, except where cover crops are in bloom. Dusting with poisonous materials, whenever practiced, is usually or often exceedingly damaging to bees and to other insects capable of pollinating fruit blossoms. Unless dusts are applied when the wind is not blowing, a cloud may drift for considerable distances from the point of application, often fallng on flowers of different species then in bloom, from which the bees gather it. In certain apple regions of New York where dusting is prevalent, honeybees have been reduced so greatly that short crops have become common. It will of course be evident that poisoning from dusting not only kills bees but that it causes the more extensive beekeepers to remove their apiaries to safer locations, which is a more immediate result of dusting even than the death of colonies. Small holders soon lose their bees and discontinue beekeeping.

The need for more pollinating insects brings to the front certain beekeeping problems, and while it is the task of those interested in the development of beekeeping to find a proper solution for these problems, at the same time it is well for entomologists to know what these prob-

lems are so that they may better appreciate their seriousness and so that they may be aware of the influences which their recommendations may have on the problem.

If a fruit grower decides to bring to his orchard honeybees for pollination purposes, it is to his advantage to bring in colonies which will work effectually. It must for the present be assumed that in the majority of cases the orchardist is not a beekeeper and that he cannot accurately evaluate the colonies which he may rent or buy. A strong colony will rush into the orchard at least four times as many bees as one of half strength, and the increase in the number of flying bees is not in proportion to the actual number of bees in the hive. A colony of bees having at the time of apple blossoming six frames of brood is perhaps above an average colony under fair management for this time of year in those regions where the beekeeper is aiming to have his colonies ready for clover when it comes into bloom in June. On the other hand by proper wintering and spring care, it is often possible to have twice that much brood at the time that apple comes into bloom. This means that a different, better and more difficult management is required when the chief aim is to obtain pollinating agents. Methods for getting stronger colonies are well enough known. The average orchardist who is not a skilled beekeeper will not once in a thousand times get colonies of proper strength, and unless he takes up beekeeping as a serious part of his study and work, he cannot expect to get the results from bees under his own management which he should get. This means that it is rarely profitable for the orchardist merely to buy some colonies and to place them somewhere within summer flight distance of his trees.

It is also evident that the average beekeeper cannot furnish colonies of the best strength for the work desired, and that only the beekeeper who makes preparation for fruit pollination a definite part of his management can furnish colonies of useful strength. There are probably not enough such beekeepers at present in or near any of the eastern fruit areas. This makes it desirable that steps be taken to see to it that the fruit grower gets a square deal when he rents colonies, otherwise the results obtained will not be satisfactory and the necessity of bees in the orchard will not be convincingly shown. It is difficult to arrange that the fruit grower get the best colonies because he cannot himself evaluate them but must depend on a skilled beekeeper to determine colony strength.

In Massachusetts Mr. C. L. Farrar has attempted this by suggesting prices for rental based on the number of frames covered with bees when the outer temperature is 60 to 65° F. at the time of delivery at the

orchard, an observation which can be made by one who is not a beekeeper. He suggests a $5.00 rental as a basis for computation, with a reduction of $1.25 for each frame covered less than five and an addition of $1.00 for each frame covered over six. The number of colonies needed may be increased or decreased accordingly. This proposal is a step in the right direction, but the basis for computation is questionable, for no colony covering less than six frames is worth carrying to the orchard, unless perchance the air temperature exceeds 70° for some time during fruit bloom. A better basis would be to demand that no colony covering less than six frames be used and to base the computations on a cluster spread of ten frames.

It should be evident to any person informed about bees that a colony in a single hive body of standard size is a poor agency for the fruit grower to bring to his aid. Better beekeeping methods demand that colonies wintered outdoors be kept in two full depth hive bodies throughout the winter, and the average beekeeper who does not follow this practice cannot once in a score of seasons furnish colonies worth much to the orchardist. By the time that the bees are to go to the orchard, they will under proper care have filled both hive bodies to a considerable extent, although there will still be corners not filled at lower temperatures. With exceedingly strong colonies there will be a possibility, amounting almost to probability, that the bees will swarm during fruit bloom unless steps are taken to prevent this misfortune to the beekeeper. Since it is usually not practicable to manipulate bees while in the orchards, this means that colonies of the proper strength should not go to the orchard even in two hive bodies but that a third, empty hive body should be given them as a preventive of swarming and to prevent undue crowding in the event of a good nectar secretion from the fruit blossoms. To carry colonies to the orchard in three hive bodies is a trying task. This means that the beekeeper must demand higher rentals for such colonies, but as Farrar has pointed out for weaker colonies, the number of colonies needed in any orchard may be proportionately reduced, so that exceedingly strong colonies should be much cheaper per acre for the orchardist. One excellent colony will easily cover four acres in any weather when the bees can fly, whereas basing recommendations on weak colonies, one colony to the acre is usually recommended. The demand that all colonies be strong will actually work to the advantage of the beekeeper by leading him into better methods of management.

Cluster spread, while easily observed by one not familiar with bees, is not the safest possible guide, since excitement of some sort may

cause the bees to spread beyond their usual cluster space. The temperature within the hive governs this rather than the outer temperature. A safer criterion would be the frames containing brood. Ten frames of standard size containing brood, not counting combs containing eggs only, is a fair basis of computation, for it is quite within the range of beekeeping possibilities for a skilled beekeeper to have such strength in average colonies at the time of fruit bloom. If the rental is computed on the basis of $10.00 for such colonies and if it is planned to place one such colony on each four acres, this will lead to better beekeeping and to far better service to the orchardist. The count of brood frames will of course include some frames in the central part of the cluster which are well filled and others at the edges which are only slightly filled, but if combs containing eggs only are eliminated, this gives a fair and measurable criterion. Naturally only the beekeeper owning the bees or some other beekeeper can make this determination, but unless the beekeeper is honest enough to report a true count, he is not a proper person with whom the orchardist can deal.

Trials of the use of package bees shipped into northern orchards just before fruit bloom have been made, and some of these tests have been unsatisfactory, since some fruit growers have simply left these packages, containing originally in some cases a frame or two of comb foundation, in the orchards. They almost at once become equivalent to box hives which are a menace. It is nevertheless possible to use such packages to great advantage, and in some fruit areas it will be wholly impossible to get enough colonies of bees for proper pollination by rental of full colonies. Two plans are proposed for this purpose, the temporary one being much preferable.

Package bees for temporary use should be ordered to arrive about one week before the earliest opening of the fruit blossoms. Arrangements should be made with some experienced beekeeper to furnish a bottom board, double cover, two hive bodies, five drawn combs and a feeder of at least 5 pounds capacity for each package ordered. If possible the beekeeper should make the installations and should feed the bees daily until they surely have enough stores to last through the blossoming period. One package of three pounds should be supplied for each acre of fruit. Such packages have the advantage that the bees have at first no brood for which to care and they are young vigorous bees. Just as soon as the petals have dropped, the beekeeper should be asked to remove the bees from the orchard, and he should be given the bees as his compensation for the use of the equipment and for his labor in their care and transportation. By doubling them up, the beekeeper

can make a smaller number of colonies for clover gathering, or he can use them to advantage in strengthening his colonies or in other ways. He will get only about a fair compensation for his work if he gets the bees without charge.

Another way to use package bees from the south is to get them earlier, help them to build up for three to four weeks before the blossoming period and then to keep them permanently in or near the orchard. This makes it necessary that the orchardist become a real beekeeper if he is to get later service from the purchased bees, and since he probably will not become a skilled beekeeper in the majority of cases, this plan is rarely to be recommended.

American foulbrood is prevalent in many fruit areas or adjacent to them. If diseased bees are moved about, this vastly increases the danger of spreading infection, and moving should not be permitted without inspection of the colonies at some time which will insure their freedom from this disease. If many bees are moved, it will be impossible to have the colonies all inspected before they should be moved to orchards, because of the short time available and chiefly because of the uncertainty of the weather at that season. This means that those beekeepers who plan to engage in rental of bees should have their apiaries inspected the fall before and they must be given a permit to move based on the fall inspection. This is moderately but not entirely safe. The inspector who grants such a permit should aim so far as possible to inspect the bees while in the orchards, and in granting the permit he should stipulate that if any colonies are found infected on orchard inspection, they will be burned on the spot and the beekeeper will then receive no rental. This will increase the care of the beekeepers in their own inspections before moving.

It has been suggested that when colonies are inspected in the orchards, the inspectors mark on the outside of each colony the number of frames containing brood, thus assisting the orchardist to make his own computations of the rental due the beekeeper. This would have some disadvantages to the apiary inspectors, but is not without merit.

Under present dusting practices in many fruit areas, beekeeping within the fruit areas is too uncertain to be recommended. This means that at present the fruit grower who plans to own his own bees or the beekeeper who plans to rent bees for orchard use should plan to keep them outside the fruit areas except during the short period when they are needed for pollination. This often means a moving of twenty to fifty miles or more if a suitable permanent site is found. This in turn means that if the fruit grower undertakes to be a beekeeper, he at once

embarks on outapiary management, which is the most difficult phase of beekeeping. Under such conditions it would be the height of folly to recommend to a fruit grower that he produce comb honey.

The difficulties of getting colonies ready for pollination work have been intentionally emphasized to prevent entomologists from giving their fruit growing constituents bad advice about engaging in beekeeping. In a few instances such advice has been given by horticulturists, entomologists and county agents, leading the fruit grower to believe that he has taken the necessary steps as to honeybees, whereas as a matter of fact he is in extremely poor condition. These warnings are based on some experience recently in attacking this problem and from reading of the advice already given from other workers, some of which seems to be thoroughly unsound. It is hoped that these remarks may help to adjust this question to the advantage of all concerned.

A PRACTICAL HONEYBEE SHIPPING CAGE FOR USE IN POLLINATION[1]

By Ray Hutson, *Assistant Entomologist, New Jersey Agricultural Experiment Station*

Abstract

Observations on a shipping cage designed for use as a hive in the orchard indicate that it is possible for bees to be prepared at the shipping point for use in orchards. Bees prepared, shipped, and used in this way compare favorably with packages hived in the orchard as to shipping, handling, and salvage value.

The steadily growing practice of using honeybees in orchards at blooming time to effect pollination is constantly creating new problems. This paper is an account of an effort to devise a workable means of providing bees for pollination to supplement the existing supply of overwintered bees if for any reason such aid is needed. The solution proposed in this paper is that of a shipping package designed, to conform to the legal requirements of shipment, to need little knowledge of bees in handling, and lending itself to economical disposal after pollination is completed. The considerations leading to work on such a shipping package are numerous. Orchardists are sometimes unable to procure bees in their own neighborhood. Beekeepers do not have or want to rent bees for example. The number of hives in a neighborhood may be insufficient for the pollination needs. A shipping package meeting the criteria named above could be shipped according to previous arrangement by the package men in the south. The receiver with the exercise

[1]Paper of the Journal Series, New Jersey Agricultural Experiment Station, Department of Entomology.

of nothing more than muscular effort could place the shipping package in the orchard and release the bees. After pollination the entrance to the shipping cage could be stopped and the bees removed from the orchard for disposal by sale, salvage, or destruction as the owner might decide.

These desiderata are met by a modification of the 3 frame nucleus shipping cage widely used by southern shippers. This cage is a solid box except for half screened sides and holds 3 Hoffman frames. The cover is semi-telescoping; the ends extending 2½ inches down to afford a holding place for the screws usually used to hold it in place. In the modification, 2 frames containing 1 inch starters and 1 frame having a light wooden box built upon it near the top bar to hold 2 pounds of queen cage candy are substituted for the 3 combs in the usual 3 pound nucleus, and the queen secured in a provisioned queen cage. The escape hole in the queen cage is secured by a cork stopper attached by a wire to the entrance stop of the nucleus box. Removal of the entrance stop pulls the cork from the queen cage giving the bees opportunity to release the queen. The cover is prevented from warping on exposure to the weather by a narrow strip of tin tacked across its middle. Shipping packages containing 3 pounds of bees with a caged queen cost $5.25 laid down at the consignee's express office last spring.

The shipping packages were taken from the express office to the orchard, wrapped in one thickness of roofing paper to protect them from the weather, and distribution made. The entrance stops were removed as the shipping packages were placed. The removal of the shipping packages from the orchard was accomplished without mishap by replacing the entrance stop, loading and hauling them away.

Observations at the time the bees were placed showed very few bees dead in the shipping packages. The strength of 11 overwintered hives already placed in the orchard when the packages were distributed showed an average of 2.5 pounds of bees.

The labor in placing the packages was less than that of placing an equal number of hives as 3 packages are lighter than one 1 story 10 frame Langstroth hive and occupy about the same space. Wrapping each cage required about 2 cents worth of paper and twine. The use of paper was cheaper, easier and afforded a better protection for the short period in the orchard than the use of small boards. The paper afforded better protection because there were no crevices for water to enter.

The removal of the special packages from the orchard was easier than removing an equal number of hives because of the lightness and small space occupied. The honeyflow in the orchard was meager.

The package bees, as evidenced by their activity in carrying apple pollen, were as active as overwintered bees in working apple blossoms.

The salvage value of packages made up in the described manner and treated as outlined compares favorably with regular 3 pound packages hived in the orchard. At the end of the blooming period 20 shipping cages showed 2 queenless contrasted with an equal loss of queens in regular packages. The brood area of 18 queen right shipping cages averaged one-half frame less brood and eggs per cage than an equal number of regular packages. The shipping packages had small sections of the foundation drawn when they arrived. There were no cross combs. At the end of the blooming period the transfer of the two drawn combs and the bees from the shipping packages to hives was accomplished in less time than that expended in getting hives ready in the orchard and putting an equal number of regular packages into them. About ½ pound of queen cage candy remained at the end of the blooming period in spite of 8 days continuous bad weather.

There was no honey flow permitting a comparison of crop from the shipping cages.

The facts brought out in this trial of shipping packages for orchard pollination should help to provide a means for supplementing the number of hives available for pollination. It enables the orchardist on his own, or through a beekeeper, to supply himself with standard colonies of bees at a reasonable cost and a minimum of beekeeping knowledge. From the beekeeper's standpoint it is possible at this year's prices for the packages and for pollination, to increase his number of colonies very cheaply by buying shipping packages and salvaging them after he has rented them to the orchardist. The small amount of beekeeping knowledge required to place shipping cages in orchards and to remove them should appeal to the beekeeper who must depend on help.

The observations gathered in this trial of shipping packages purchased from a reputable source for pollination seems to indicate their fitness for the service. The shipping cage used in this trial fulfilled the requirements postulated in the introduction. It can be shipped; it is easy to handle; it has a salvage value.

ETHYLENE OXIDE AS A FUMIGANT FOR FOOD AND OTHER COMMODITIES

By E. A. Back, R. T. Cotton and G. W. Ellington, *Bureau of Entomology, U. S. Department of Agriculture*

Abstract

Ethylene oxide, a recently discovered gas is an excellent fumigant for all types of foodstuffs. When used as directed with carbon dioxide it is non-flammable and non-explosive, easy and safe to use, effective against all types of stored product insects, and is reasonably inexpensive. It has been used successfully in treating stores, supply rooms, grain bins, fumigating vaults, etc., Dosages for the atmospheric and vacuum fumigation of various commodities are given.

The increasing necessity for protecting foodstuffs and other stored commodities from insect attack has created an urgent demand for all available information regarding fumigants that are adapted for treating such commodities. We are all aware of the great need for a fumigant that can be used almost anywhere without the danger of fire and explosion, or without undue danger to the health of man in congested districts, or of breaking local regulations governing the use of fumigants.

In Ethylene Oxide, when used as directed, we have a fumigant which, in addition to possessing freedom from the fire and explosion hazard and extreme toxicity to man, does not appear to leave in or upon the treated materials obnoxious odors, or residues harmful to man or animals. It is believed that many commodities will be fumigated more successfully and with less danger when the details of application, particularly with Carbon Dioxide, have been worked out. In Ethylene Oxide we have a fumigant which can be recommended with satisfaction to many commercial houses.

Ethylene Oxide has been used already with success in grocery stores, hospital food-supply rooms, in fumigable storage bins in dried fruit establishments, work rooms, candy establishments, and for treating tobacco infested with *Lasioderma serricorne*. It has been used with apparent success in large concrete elevator bins containing wheat and in lofts in reinforced concrete warehouse space storing grain products such as animal feeds. The Navy Department fumigated with excellent results over 10,000 pounds of sacked rice in a modern quartermaster's depot. In a house basement or cellar it proved an efficient fumigant against the webbing clothes moth, *Tineola biselliella*, the furniture carpet beetle, *Anthrenus vorax*, the confused flour beetle, *Tribolium confusum*, and the rice weevil, *Sitophilus oryza*. In tight fumigating rooms, no difficulty has been experienced in killing tremendous numbers

of the saw-toothed grain beetle, *Oryzaephilus surinamensis*, and the confused flour beetle in one, two and three pound cartons containing products of the nature of Farina, Rolled Oats and Corn Flakes. No living insects could be found by a careful examination of fumigated 96-pound sacks of high-grade wheat flour.[1] No living specimens of the webbing clothes moth or the furniture carpet beetle could be found in heavily infested upholstered furniture treated in a modern fumigating vault. Mr. Perez Simmons, in field charge of the Bureau's dried fruit insect investigations in California, writes as a result of experiments there, that the dried fruit industry is most enthusiastic over the use of Ethylene Oxide. In fact, it is largely due to the amount of Ethylene Oxide used by the California Dried Fruit Industry that important reductions in price per pound of the fumigant have been secured.

Dr. Cotton exhibited nut meats fumigated with Ethylene Oxide at the 1929 West Baden convention of candy manufacturers and was interested to note that none of the nut experts could detect an odor or foreign taste in this difficult food product. A New York nut importing firm examined cashew nuts, which had been variously prepared for market and fumigated with Ethylene Oxide, and stated that in no way did they appear adversely affected.

The insecticidal properties of Ethylene Oxide were first established by Dr. R. T. Cotton of the Bureau of Entomology, working in cooperation with Dr. R. C. Roark of the Bureau of Chemistry and Soils, in their paper[2] published in August, 1928.

PHYSICAL PROPERTIES OF ETHYLENE OXIDE. Ethylene Oxide at ordinary temperatures is a colorless gas. At low temperatures it is a mobile colorless liquid boiling at 10.5°C. The specific gravity of the liquid is 0.887 at 4°–7°C. The concentrated vapors of ethylene oxide are inflammable, but concentrations up to 3½ pounds per 1000 cu. ft. of space are non-explosive and non-inflammable. The ignition point is 814°F. The gas is not highly toxic to man, but when inhaled for a long time it produces a cyanosis, which, however, is counteracted by the use of carbon dioxide as an antidote.

COST OF ETHYLENE OXIDE. Owing to the fact that until very recently there has been no commercial demand for ethylene oxide, the cost is somewhat high. It may be bought in small lots for one dollar per pound and in large lots for 75 cents per pound.

[1]The flour and cartoned cereal contained, by actual count, from several hundred to 20,000 larvae, pupae and adults of the saw-toothed grain beetle, *Oryzaephilus surinamensis*, and the confused flour beetle, *Tribolium confusum*, per sack or carton.

[2]R. T. Cotton and R. C. Roark, "Ethylene Oxide as a Fumigant," Ind. and Eng. Chem., Vol. 20, No. 8, pp. 805, Aug., 1928.

Adsorption of Fumigants by Foodstuffs. For the successful fumigation of any commodity it is necessary to know something of the adsorption capacities of the material. Until rather recent times it has been the tendency to recommend the amount of a fumigant to be used on the basis of the amount of space to be fumigated regardless of the type of commodity contained therein. Recent experiments have shown, however, that whereas some foodstuffs adsorb but little of a gas, others adsorb so much that ten times the normal dosage may be required to obtain a complete kill.

Numerous experiments have therefore been conducted with different types of foodstuffs in order to determine the proper dosages of ethylene oxide required to fumigate them successfully. Although by no means complete, the results of the investigations with foodstuffs herein given will be found useful in indicating the proper amounts needed for treating various foodstuffs under varying conditions.

Recommendations are given for both atmospheric and vacuum fumigation. Quicker results may be obtained by use of a vacuum tank, but a correspondingly greater amount of the fumigant must be used in order to get satisfactory results.

The use of carbon dioxide in combination with ethylene oxide recently advocated by Cotton and Young[3] greatly increases the efficacy of the fumigant, hence dosages for its use in vacuum fumigation are included in Table 1.

In addition to increasing the insecticidal action, carbon dioxide when mixed with ethylene oxide at the rate of seven parts to one by weight completely removes the possibility of fire hazard that might result from an accidental overdose or the concentration in one spot of an excess amount of the fumigant. For this reason it is recommended that carbon dioxide be used in combination with ethylene oxide wherever practical.

In vacuum fumigation work the carbon dioxide is drawn into the vacuum tank first and is then followed by the ethylene oxide. Approximately 14 pounds of carbon dioxide per 1000 cu. ft. of space is the dosage recommended except for the fumigation of nut meats when double the amount should be used.

The recommendations are based on vaults and tanks filled to capacity. If a vault or tank is only partially filled with the material to be fumigated a smaller amount of the fumigant will in some cases suffice.

[3]R. T. Cotton and W. D. Young, The Use of Carbon Dioxide to Increase the Insecticidal Efficacy of Fumigants. Proc. Wash. Ent. Soc. Vol. 31, No. 5, 1929.

DIRECTIONS FOR APPLYING ETHYLENE OXIDE. Ethylene oxide is obtainable in liquid form in cylinders. If small amounts only are used it can be drawn off by gravity flow into a tall glass jar, weighed or measured, and then poured directly into the evaporating trough or pan of the fumigating vault. As the liquid is highly volatile at ordinary temperatures it should be handled with speed, and the fumigating vault should be loaded and ready before the fumigant is drawn from the cylinder.

Where large amounts are to be used, and for vacuum fumigation, it is desirable to have a graduated applicator into which any required amount of the liquid can be drawn. The applicator should be attached to the vault or vacuum tank so that the opening of a valve will allow the measured amount of liquid to run or be drawn into the fumigation chamber. Connections between the cylinder of ethylene oxide and the applicator should be of metal tubing rather than of rubber, as rubber is affected by the liquid.

The temperature of the stocks and the room during the experiments reported upon below ranged from 75° to 78°F, and the dosages recorded are based upon the results obtained during these experiments.

RICE. Polished rice can be treated either in bulk or in sealed cartons. It does not adsorb much of the gas, and comparatively small amounts of the fumigant are very effective against the insects that attack it. Bulk rice is more easily fumigated than packaged rice since more gas is required to penetrate the tightly sealed cartons. The dosages recommended are based on tests with adults and larvae of *Tribolium confusum*, larvae of *Plodia interpunctella*, and larvae of *Tenebrioides mauritanicus*, as they are more resistant to the vapors of ethylene oxide than other rice infesting insects. The rice weevil, *Sitophilus oryza*, which is regarded by many as the worst insect pest of rice, is very susceptible to this gas, and may be killed in as short a time as 10 minutes.

In atmospheric fumigation, bulk rice can be freed of insect life by the use of one pound of ethylene oxide per 1000 cu. ft. of space during an overnight fumigation. Under similar conditions rice in cartons requires a dosage of two pounds per 1000 cu. ft. in order to obtain a perfect kill.

In vacuum fumigation, ethylene oxide should be used in the proportion of three pounds per 1000 cu. ft. for one hour, or two pounds per 1000 cu. ft. for two hours, for treating bulk rice; and three pounds per 1000 cu. ft. for 2¼ hours, or two pounds for three hours, for rice in cartons. When used in combination with carbon dioxide two pounds

of ethylene oxide per 1000 cu. ft. for ½ hour, or one pound per 1000 cu. ft for ¾ hour, is sufficient for the treatment of bulk rice; and three pounds per 1000 cu. ft. for ¾ hour, or two pounds per 1000 cu. ft. for one hour, is required for the treatment of rice in cartons.

In the treatment of bulk rice by vacuum fumigation the cost of handling could be greatly reduced by having the vacuum tank set on end. The rice could then be run in at the top and drawn off through a valve at the bottom and conveyed by a travelling belt to the bins or packing machines as desired.

BEANS. Dried beans of all types may be fumigated either loose or in bags. For atmospheric fumigation two pounds of ethylene oxide per 1000 cu. ft. of space for an overnight exposure will kill all weevils present whether the beans are in bags or in bulk.

For vacuum fumigation three pounds of ethylene oxide alone per 1000 cu. ft. for one hour, or two pounds per 1000 cu. ft. for two hours, will give a perfect kill. In combination with carbon dioxide, it is necessary to use two pounds of ethylene oxide per 1000 cu. ft. for ½ hour, or one pound per 1000 cu. ft. for one hour.

Beans intended for seed purposes should not be fumigated with this gas since the vapors affect the germination.

DRIED FRUIT. For the treatment of dried raisins either in bulk or in cartons one pound of ethylene oxide per 1000 cu. ft. of space will give satisfactory results in an overnight atmospheric fumigation provided an air-tight vault is used. If the vault is not absolutely airtight, double the quantity should be used.

In vacuum fumigation two pounds of ethylene oxide per 1000 cu. ft. of space for 1½ hours, or three pounds per 1000 cu. ft. for one hour, are necessary to give a perfect kill in both bulk and packaged raisins.

In combination with carbon dioxide two pounds of ethylene oxide per 1000 cu. ft. for ½ hour, or one pound per 1000 cu. ft. for 1½ hours, is sufficient.

NUT MEATS. Nut meats adsorb a much larger amount of gas than most other foodstuffs and consequently require a correspondingly greater dose to insure a perfect kill. For the fumigation of raw, shelled peanuts or other nut meats, a dosage of three pounds of ethylene oxide per 1000 cu. ft. for an overnight exposure under atmospheric conditions is required. If used with carbon dioxide only two pounds of ethylene oxide per 1000 cu. ft. is required.

In vacuum fumigation three pounds of ethylene oxide per 1000 cu. ft. in combination with 28 pounds of carbon dioxide will give a perfect

kill in two hours. Ethylene oxide alone is not recommended for the fumigation of nut meats in vacuum owing to the excessive amount that would be required to effect a kill.

For ready reference the following table has been prepared. It contains the dosages of ethylene oxide that have been found effective for the fumigation of various foodstuffs in atmospheric vaults and in vacuum tanks.

TABLE 1. DOSAGE TABLE FOR ETHYLENE OXIDE WHEN TEMPERATURE OF STOCK AND ROOM IS 75°–78°F

Material Fumigated	Pounds of Ethylene Oxide per 1000 cu. ft. and Length of Exposure Required to Kill All the Insects Infesting the Material		
	In an Atmospheric Vault	In a Vacuum Tank	
	Used Alone	Used Alone	Used with 14 lbs. CO_2
Dried beans	2 lbs. (overnight) (or 16 hours)	2 lbs. for 2 hrs. 3 lbs. for 1 hr.	1 lb. for 1 hr. 2 lbs. for ½ hr.
Dried raisins	1 lb. (overnight) (or 16 hours)	2 lbs. for 1½ hrs. 3 lbs. for 1 hr.	1 lb. for 1½ hrs. 2 lbs. for ½ hr.
Rice in bulk	1 lb. (overnight) (or 16 hours)	2 lbs. for 2 hrs. 3 lbs. for 1 hr.	1 lb. for ¾ hr. 2 lbs. for ½ hr.
Rice in cartons	2 lbs. (overnight) (or 16 hours)	2 lbs. for 3 hrs. 3 lbs. for 2¼ hrs.	2 lbs. for 1 hr. 3 lbs. for ¾ hr.
Nut meats	3 lbs. (overnight) (or 16 hours)		3 lbs. for 2 hrs.[1]

[1]28 lbs. of CO_2 per 1000 cu. ft. should be used in the fumigation of nut meats.

It should be noted that although insects, that have been fumigated with the vapors of ethylene oxide for the short periods recommended in vacuum fumigation, are quite active when first removed from the fumigation chamber, they die within a few hours. Just what is the physiological effect upon the insect has not been determined.

CARBON DIOXIDE AS AN AID IN THE FUMIGATION OF CERTAIN HIGHLY ADSORBTIVE COMMODITIES

By R. T. COTTON, *U. S. Bureau of Entomology*

ABSTRACT

The fumigation of highly adsorbtive commodities, such as nut meats, in vacuum is greatly facilitated by the admixture of carbon dioxide with other gases.

When speed is essential in the fumigation of any product the vacuum fumigation method is resorted to. By this method results may be obtained in from one to two hours that would take from 12 to 14 hours to obtain by atmospheric methods.

In order to obtain these quicker results, however, it is necessary to use correspondingly larger amounts of fumigants. Carbon disulfide for example will give a satisfactory kill in an atmospheric fumigation

vault at a dosage of two pounds per 1000 cu. ft. of space for 24 hours, whereas, it is customary for commercial fumigators to use as high as 40 pounds per 1000 cu. ft. in vacuum fumigation.

It is well known that in an empty fumigation chamber, within certain limits, the time required to kill a certain insect is in direct proportion to the dosage. If, however, the fumigation chamber is filled with merchandise, the factors of adsorption and absorption come into play and present problems that are difficult to overcome.

The amount of adsorption or absorption is not constant. It varies first with the type of merchandise being fumigated, second with the fumigant being used and third with the temperature. In regard to the effect of temperature, Strand[1] in 1927 found that as the temperature decreased the adsorption increased.

The difficulties, due to adsorption, experienced by various commercial firms in the fumigation of nut meats induced the writer to conduct a series of experiments, some of the results of which are given herewith.

The experiments were conducted in small vacuum tanks, 8.7 liters and 21.76 liters in capacity. The insects used were adults of the confused flour beetle, *Tribolium confusum*, put up in cotton stoppered vials. This species was chosen because it is more resistant to the gases used than any of the common pests of stored nut meats. The insects were placed as near as possible to the center of canvas bags filled with raw peanuts. Each bag held approximately 2½ pounds of peanuts and in all fumigations the vacuum tanks were filled to capacity with these bags. Four glass vials, each containing ten insects were used in each test. In all experiments the temperature was approximately 72°F.

TESTS WITH CHLOROPICRIN. In an empty vacuum tank it required two ounces of chloropicrin per 100 cu. ft. of space to give a 100 per cent kill of *Tribolium confusum* adults in two hours at a temperature of 72°F. When the tank was filled to capacity with raw peanuts it was found impossible to obtain a 100 per cent kill in two hours even when a dose of 48 ounces per 100 cu. ft. was used.

In an endeavor to obtain a kill in two hours with a reasonable amount of chloropicrin, tests were made with various mixtures of chloropicrin and carbon dioxide.

After the customary 27 inches of vacuum was drawn the carbon dioxide was admitted to the tank followed immediately by the chloropicrin.

[1]Strand, A. L., Univ. of Minn. Agr. Expt. Sta. Tech. Bul. 49, p. 17, 1927.

It was found that up to a certain point, the more carbon dioxide that was used the less chloropicrin was required to give a kill. When used with carbon dioxide at the rate of 2.8 pounds per 100 cu. ft. of space seven ounces of chloropicrin gave a 100 per cent kill of *Tribolium confusum* adults in two hours with the tank filled with raw peanuts. With 4.2 pounds of carbon dioxide per 100 cu. ft., 4 ounces of chloropicrin per 100 cu. ft. gave a 100 per cent kill.

Experiments in an empty vacuum tank for 30 minute exposures at 72°F. indicated that the addition of carbon dioxide up to approximately the rate of 4.2 pounds per 100 cu. ft. of space adds to the toxicity of chloropicrin in proportion to the amount of carbon dioxide used. Higher percentages of carbon dioxide apparently do not increase the toxicity of chloropicrin beyond this point. To summarize the experiments briefly, a one hundred per cent kill of *Tribolium confusum* was obtained in 30 minutes, with 6.6 ounces of chloropicrin per 100 cu. ft. when used alone; with 4.6 ounces of chloropicrin when used with 1.4 pounds of carbon dioxide per 100 cu. ft.; with two ounces of chloropicrin when used with 2.8 pounds of carbon dioxide per 100 cu. ft. and with 1.28 ounces of chloropicrin when used with 4.2 or more pounds of carbon dioxide per 100 cu. ft. of space.

EXPERIMENTS WITH ETHYLENE OXIDE. Experiments with ethylene oxide indicate that this gas is not adsorbed or absorbed by nut meats to such an extent as is chloropicrin.

In an empty vacuum tank ethylene oxide used alone at the rate of 3.2 ounces per 100 cu. ft. of space gave a 100 per cent kill of *Tribolium confusum* adults in two hours at 72°F. With the tank filled with raw peanuts it required 11.2 ounces of ethylene oxide per 100 cu. ft. to give a 100 per cent kill in two hours.

With the addition of carbon dioxide at the rate of 2.8 pounds per 100 cu. ft. four ounces of ethylene oxide gave a 100 per cent kill in two hours with the tank filled with peanuts.

Larger amounts of carbon dioxide did not materially increase the toxicity of ethylene oxide.

Additional experiments with other highly adsorbtive materials indicate that carbon dioxide can be used to advantage with other gases in the fumigation of many materials that have hitherto been difficult or impractical to successfully fumigate.

SOME DEVICES FOR HANDLING INSECTS

By George Wishart, *Dominion Parasite Laboratory, Entomological Branch, Belleville, Ontario*

Abstract

The paper deals with new apparatus for handling adult insects by use of air currents. These have been developed in connection with the breeding and handling of parasitic insects and their hosts at the Dominion Parasite Laboratory, Belleville, Ontario.

In rearing large numbers of parasitic insects and their hosts, the handling of the live adults forms a major part of the work. Until recently most of this handling in our laboratory was done with a camels hair brush, the insects being brushed off the cage into a vial or other receptacle. The apparatus described in this paper was devised to reduce the labour involved in this operation, and as far as possible, to eliminate injury to the insects handled.

In the case of one insect, *Microbracon brevicornis* Wesm., it is necessary to place three or four adults of each sex in a small Stender jar. To fill a few hundred jars from a cage containing thousands of active adults by the old method was a patience-trying task, and usually fatal

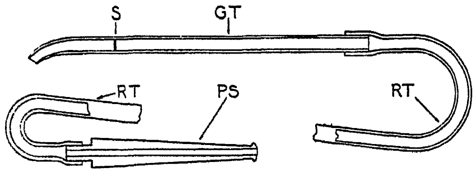


Fig. 20.—Simple suction catching apparatus. See Fig. 23 for explanation of lettering.

to many of the flies. The device shown in Figure 20. has greatly reduced the labour involved in this operation. It consists of a small piece of glass tubing shaped into a nozzle and having a screen placed at a convenient distance from the opening. This is connected by about 18 inches of rubber tubing to an ordinary large pipe stem. To operate, the pipe stem is held in the mouth and the glass tube in the hand, the open end of the tube is held near the insect to be caught and the breath drawn in. The suction thus created draws the insect into the tube and the screen prevents it from being drawn into the mouth. When the desired number of insects have been caught and it is desired to release them, the open end of the tube is placed where they are wanted and they are expelled by blowing gently through the tubing. In the case of small insects, the size of *Microbracon*, large numbers may be handled by this method

without any appreciable fatigue to the operator. In nearly three years' use with the species mentioned no injury to the insects has been noted when the apparatus was used with reasonable care. This type of apparatus has been suited to insects of various sizes by changing the size of the nozzle, but with the larger forms its continued use becomes tiring to the operator due to the greater amount of air required.

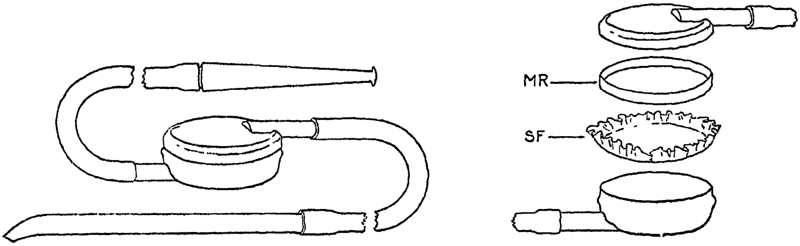


FIG. 21.—Catching apparatus with filter for handling lepidoptera. See Fig. 23 for explanation of lettering.

For handling small lepidoptera, the presence of wing scales prohibits the use of the apparatus in this form. To make possible its use, a small filter (Figure 21) is inserted in the line of the rubber tubing. This is made from a two inch salve box. A piece of metal tubing is fastened to the top and bottom of the salve box and a piece of fine silk which acts as the filtering agent is held between these by a metal ring. In handling moths similar in size to the Oriental Peach Moth (*Laspeyresia molesta* Busck.), it was found that the hole in a pipe stem is not large enough to allow sufficient suction and a mouth piece of hard wood was made, which has proven to be satisfactory. Modifications in the position of the screen and the size of the nozzle may be made to suit individual requirements. One worker using this apparatus reports handling over 600 adults of the Oriental Peach Moth in one day, with very little fatigue and no irritation at all to the throat and lungs.

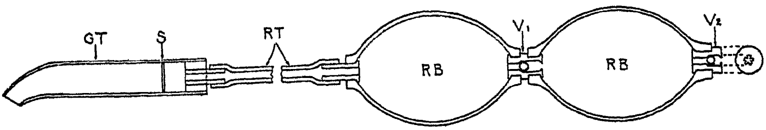


FIG. 22.—Catching apparatus operated by hand power for handling lepidoptera. See Fig. 23 for explanation of lettering.

Another piece of apparatus (Figure 22) operated by hand was also devised for handling lepidoptera. The nozzle of this is essentially the

same as that of the former and is attached to the rest of the apparatus by about 2 feet of rubber tubing. The rubber bulbs are those commonly used on atomizers. The one remote from the nozzle has the valves reversed so that instead of blowing it always sucks when pressed and released. The other bulb has no valves and when the sucking bulb is being used acts only as a tube. In use, the bulb which has valves is pressed and the nozzle placed near the insect to be collected, and when the pressure is released, the suction thus created draws the moth into the tube. To expel it the other bulb is pressed quickly. When this is done some air escapes through the sucking bulb but enough is forced out through the nozzle to expel the moths.

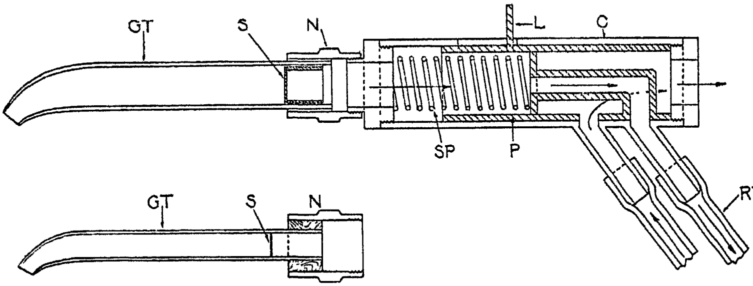


FIG. 23.—Collecting apparatus used in connection with vacuum cleaner. C, Cylinder; G T, Glass Tubing; L, Lever; M R, Metal Ring; N, Brass Nipple; P, Piston; P S, Pipe stem; R T, Rubber tubing; S, Screen; S F, Silk Filter; S P, Spring; V1, V2, Valves.

When numbers of fairly large insects are to be handled, the use of the breath as a source of draft becomes impracticable and some mechanical method must be used. Where vacuum and compressed air are piped throughout the laboratory the problem is simple, requiring only a simple two way valve attached to a collecting nozzle. In the Belleville laboratory where these devices are being used such facilities are not available and use was made of the only mechanical source of draft viz. an ordinary vacuum cleaner. This provides both suction and draft but does not allow for either being cut off while the other is being used. That is, while the machine is being used for sucking purposes, the blowing opening of the cleaner must be open to the outside and vice versa. The apparatus shown in Figure 23 provides for this. With the exception the catching nozzle and the spring, all parts are of brass. The rubber tubing on the right connects with the suction opening of the cleaner and the tube on the left with the blowing opening, the place which is usually occupied by the dust bag. Two lines each eight feet long of

three-eighths rubber tubing are used to connect the collector to the cleaner; these are bound together with adhesive tape to prevent them being in the way more than is necessary. In the position in which the piston is shown the insects are drawn into the nozzle by the suction of the cleaner. At the same time the air coming from the blowing tube escapes through a vent in the piston and a hole in the rear of the cylinder, as indicated by the arrows. As is the case in the other apparatus, a screen prevents the insects from going farther than the glass tube. When it is desired to release the insects the lever is pressed forward. This moves the piston forward until the hole which was previously opposite the sucking connection is now opposite the blowing connection. The air is now flowing out through the nozzle and the insects are forced out with it. At the same time the suction tube to the cleaner is open to the air through the hole in the rear of the cylinder. Different sizes of nozzles are used for different insects as shown in Figure 23. These are easily attached or separated from the rest of the catcher, each one being cemented into a threaded brass nipple.

It was found, no matter how strong a draft was used, that some of the larger hymenoptera could hold on sufficiently to the inside of the tube to prevent their expulsion. To facilitate their removal, the screen, which is of forty mesh wire, is fastened to a small light metal cylinder. This is fitted into the tube loosely enough to be blown back and forth as the direction of air changes. When in the sucking position the screen is in the position shown in Figure 23. When changed to the blowing position, the screen moves forward causing the insects to lose their foothold and be blown from the tube.

A neutral position may be provided in which the piston is between the sucking and blowing positions and there is no movement of air in the catching nozzle. We have found this of value when examining for the presence of secondary parasites or other unwanted species.

A METHOD OF SECURING EGGS OF THE ANGOUMOIS GRAIN MOTH

By George W. Ellington, *Asst. Entomologist, Bureau of Entomology, U. S. Department of Agriculture*

Abstract

A description of apparatus used to obtain eggs of the Angoumois grain moth in large numbers.

Entomologists engaged in the rearing of certain parasites, especially *Trichogramma minutum* (*pretiosa*) Riley, have sent so many requests to the Bureau of Entomology for a method of obtaining eggs of the An-

goumois grain moth, *Sitotroga cerealella* Oliv., that the writer has been asked to describe how he has obtained moth eggs for shipment to various investigators. The simple method described and illustrated herewith is that used by Mr. Perez Simmons and the writer during their study of the biology of the Angoumois grain moth. It is not a new method by any means, for it has been employed in the Bureau for obtaining the eggs of certain other stored-product pests.

When wheat or corn infested with the Angoumois grain moth is kept in large battery jars, covered with cheese cloth, the adults can be collected in vials as they crawl up the side of the jars. Or the infested grain can be brought to a closed window and the moths collected from the window panes as they fly from the grain.

About thirty to fifty adults can be placed in a vial 4 by 1 1/8 inches. The vial can be closed by using a pill-box cover held in place with a rubber band as indicated in Plate 8-A. Two strips of fairly stiff cardboard cut and clipped together as shown in Plate 8-B are inserted, the end with the triangular cut entered first, for it aids in preventing the crushing of moths.

The females deposit their eggs between the two strips in large numbers, as indicated in Plate 8-C. The strips should be removed as often as experiments require, as when they are left for longer than two days the moths tend to oviposit on the sides of the vial and on the underside of the covers. Since the majority of the eggs are deposited in from three to four days after emergence, newly emerged adults should be collected daily in order to insure a continuous supply of eggs.

THE RELATION OF THE SURFACE TENSION OF SOME SPRAY MATERIALS TO WETTING AND THE QUANTITY OF LEAD ARSENATE DEPOSITED[1]

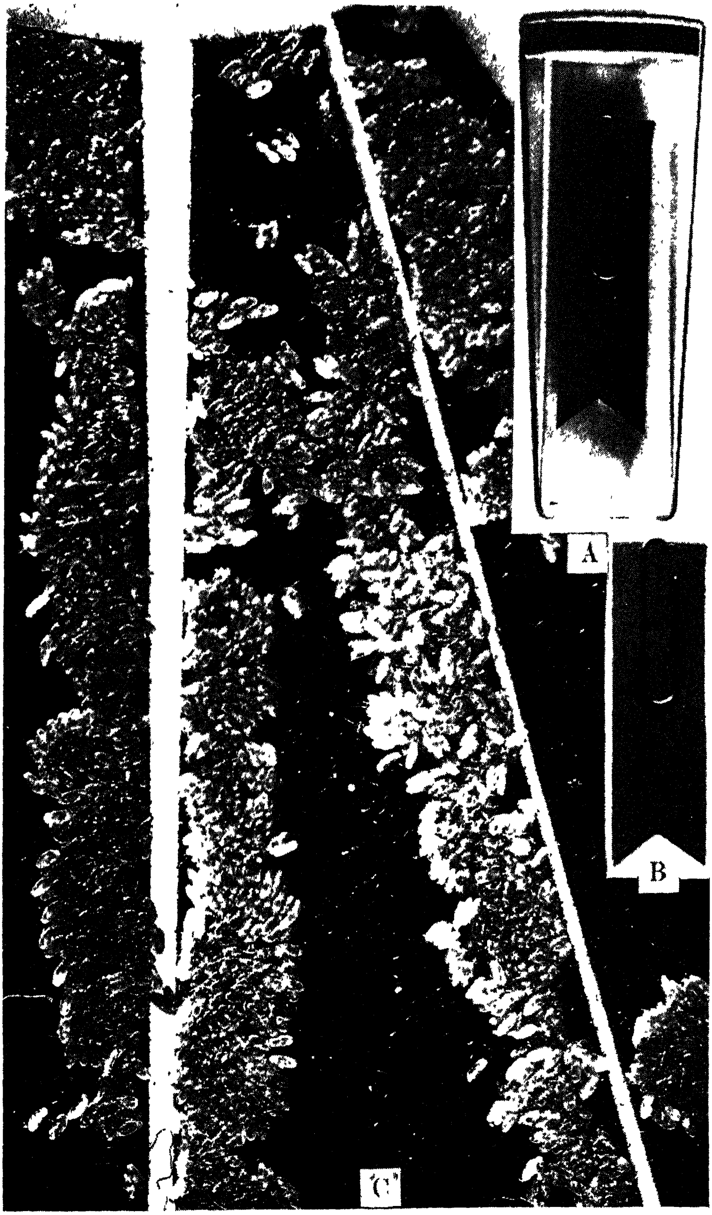
By Clyde C. Hamilton, *Associate Entomologist, New Jersey Agricultural Experiment Station*

Abstract

The paper discusses the theory of wetting and spreading of sprays containing spreader materials. The spreader materials tested were powdered skim milk plus lime, flour plus lime, saponin, casein plus lime and glue. Data and charts are given showing the surface tension curves, time required to wet clean glass plates and wax coated glass plates, and the quantity of lead arsenate deposited, when the spreader materials mentioned above were used at varying concentrations. Methods of spraying and obtaining the data are given.

[1]Paper of the Journal Series, New Jersey Agricultural Experiment Station, Department of Entomology.

Plate 8



A. Glass vial container for confining adult moths with strips of cardboard for egg-laying; B. Strips of cardboard removed from vial; C. Strips of cardboard covered with eggs.

Considerable attention is being given at the present time towards making our spray materials more effective. Of the various methods of attacking this problem one is by studying the wetting of the sprayed surface and more particular, in case of contact insecticides, the penetration of the spray into the spiracles and tracheae, while, in the stomach poisons the deposition of the poisonous material over the spray surface is receiving more attention. The efficiency of most of our insecticides can be increased several times if we can bring about a better wetting of the insect's body in the case of contact poisons, or a better distribution or large deposition of the toxic material in the case of stomach poisons. The data presented in this paper is taken from a considerably larger amount of data dealing with other phases of the wetting, spreading and adherence of arsenical spray materials.

Discussion of the Theory of Wetting and Spreading. There has been some difference of opinion regarding the meaning of the terms "wetting" and "spreading." The wetting of a solid by a liquid occurs when the liquid comes in direct contact with the solid so that no layer of air exists between the two materials. Water on the surface of a glass plate, a wax coated glass plate, a leaf or any other solid material, may be assumed to have wetted the surface of the solid if it does not roll off when the surface of the solid is tilted to a perpendicular position. On the other hand, spreading occurs when the liquid spreads or creeps over the surface of the solid so that it covers an area greater than that which it covered when first placed upon the solid. Spreading occurs when the pull exerted by the solid to become wet is greater than the pull exerted by the surface of the liquid to air. Wetting must occur before spreading can take place.

There are a number of factors which influence the wetting and spreading of liquids upon solids. Cooper and Nuttall (1) and Woodman (3) give an excellent discussion of the theory of wetting, and Moore (2) discusses the wetting and spreading of arsenical sprays. Other workers have discussed the subject but the three mentioned give excellent reviews and discuss the problem in greater detail.

Of the various factors influencing the wetting and spreading of spray materials the surface tension factors are among the most important. These are the surface tension of the liquid, the surface tension of the solid and the interfacial tension between the liquid and the solid. The surface tension of the liquid is the only one of these three factors which can be easily measured. Stellwaag (4 and 5) gives a method for determining the wetting power of liquids to solids by determining the angle formed by the liquid with the solid. This gives an approximate

value for the interfacial tension between the liquid and the solid. It is difficult to use however and has not been made use of by the writer.

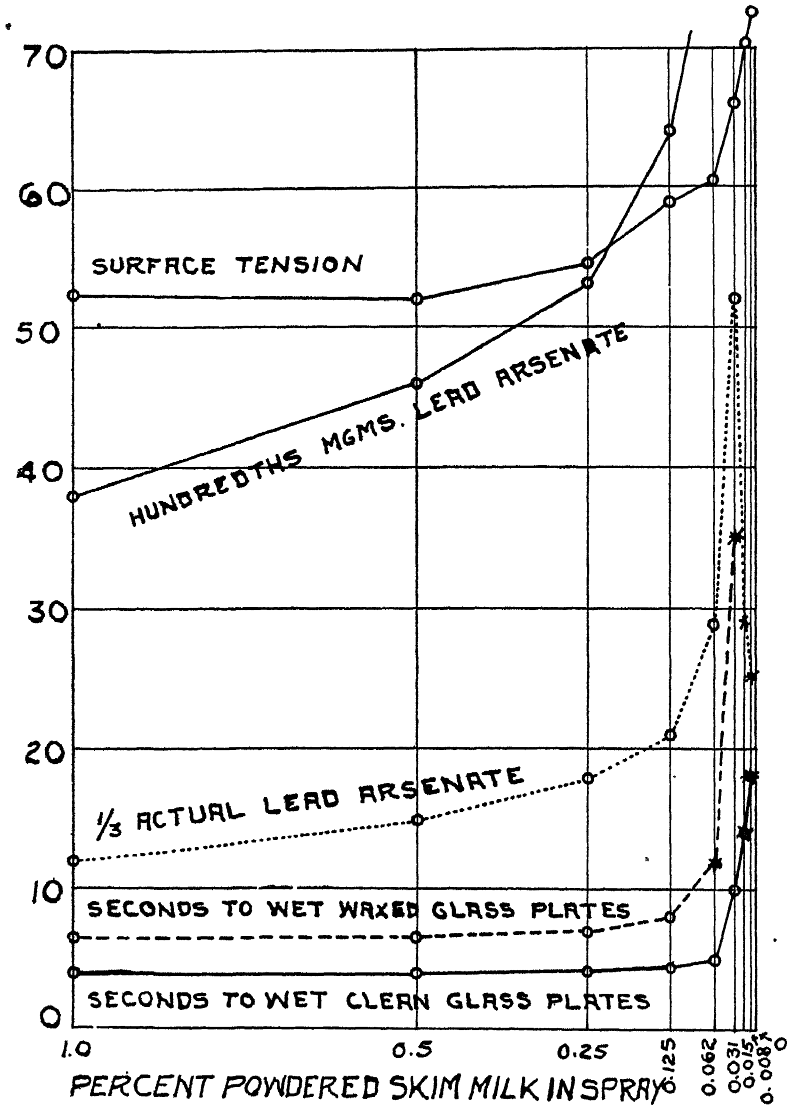


FIG. 24.—Showing the relation between the surface tension of a spray containing powdered skim milk and lime as a spreader, the time to wet the sprayed surfaces and the quantity of lead arsenate deposited. Incomplete wetting is indicated by an *

The interfacial tension values between a liquid and a solid will change with either changes in the surface tension of the liquid or the surface tension of the solid. Since the surface tension of the solid can not be obtained workers have in most cases used the surface tension of the liquid as an indicator of its wetting value.

A comparison of the interfacial tension values between liquids and solids, may be obtained by noting the time taken to wet the sprayed surface.

The wetting ability of a spray material may be obtained by determining the time required to wet uniform solids when the surface tension of the spray liquid is changed by varying the per cent of spreader material it contains. In this case we have one constant value, the surface tension of the solid, and two variables, the surface tension of the spray material, which is known, and the interfacial tension between the liquid and the solid, which is represented by the time required to wet. A second method of determining interfacial tension relations is by spraying different solids with the same spray liquid and at the same surface tension. In this case we have one constant, the surface tension of the liquid which is known, and two variables, the time to wet the different solids, which is also known, and the surface tension of the solids which is not known.

The data presented in the following pages compare the wetting of several different spray materials at different per cents when sprayed on clean glass plates and wax coated glass plates. It also shows the relation existing between the surface tension of the spray material, and the time to wet, and the quantity of lead arsenate deposited on the sprayed surface.

Methods of Procedure. The spreader materials tested were powdered skim milk plus lime, flour plus lime, saponin, casein plus lime, and glue. These spreader materials were used at the per cents indicated in the table with the addition of dry powdered arsenate of lead at the rate of 1½ pounds to 50 gallons of water or 1.8 gms. to 500 c.c. of water. Clean glass plates and glass plates coated with wax extracted from dried apple peelings were used for spraying. These plates were 4 x 5 inches and were sprayed in series of four at a time. The time noted in the tables and charts is the time required to wet four such plates and represented the average of three sprayings. The quantity of lead arsenate is given in milligrams per 10 square inches and represents the average of 5 plates or 100 square inches. The plates were sprayed by using a "Brown continuous air sprayer," of a quart capacity, keeping the nozzle a ta uniform distance of 2 feet and an air pressure of 15 pounds.

The analyses of the quantity of lead arsenate were made by dissolving the lead arsenate in a 1 per cent sodium hydroxide solution, precipitating lead sulfide with hydrogen sulfide gas and comparing the

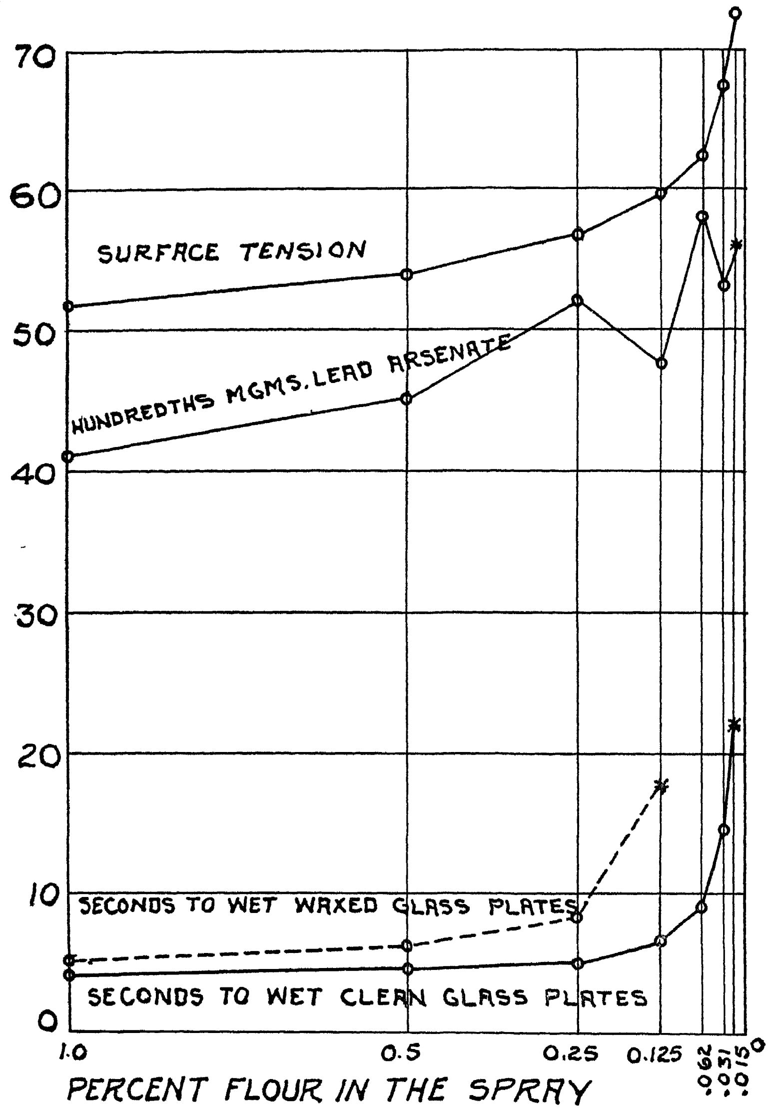


FIG. 25.—Showing the relation between the surface tension of a spray containing flour and lime as a spreader, the time required to wet the sprayed surfaces and the quantity of lead arsenate deposited. Incomplete wetting is indicated by an *.

color with known standards, Hamilton and Smith (6). A separate analysis was made for each individual 4 x 5 plate and the results given represented an average of 5 such analyses. The quantity of lead arsenate on the individual plates for each series, varied but little as long as they were uniformly wet.

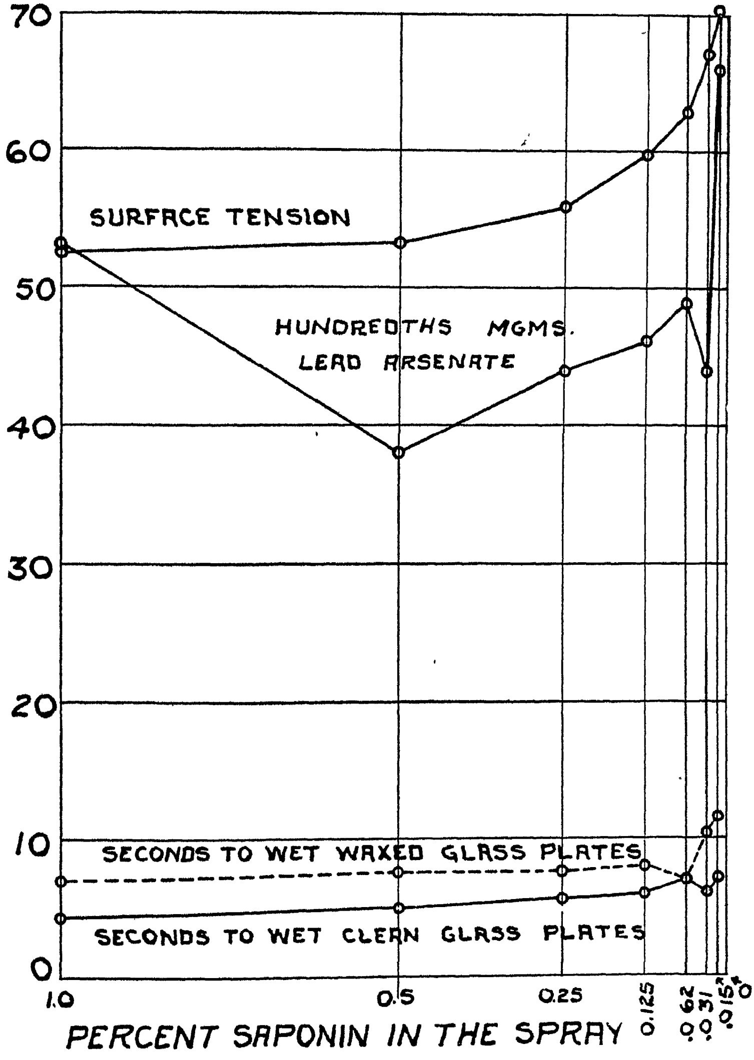


FIG. 26.—Showing the relation between the surface tension of a spray containing saponin as a spreader, the time required to wet the sprayed surfaces, and the quantity of lead arsenate deposited. Incomplete wetting is indicated by an *

Presentation of Data. The data presented in this paper is a summary of one experiment representing only a small part of the different laboratory experiments. This data is given in Table number 1 and shown graphically in Figures 24 to 29 inclusive.

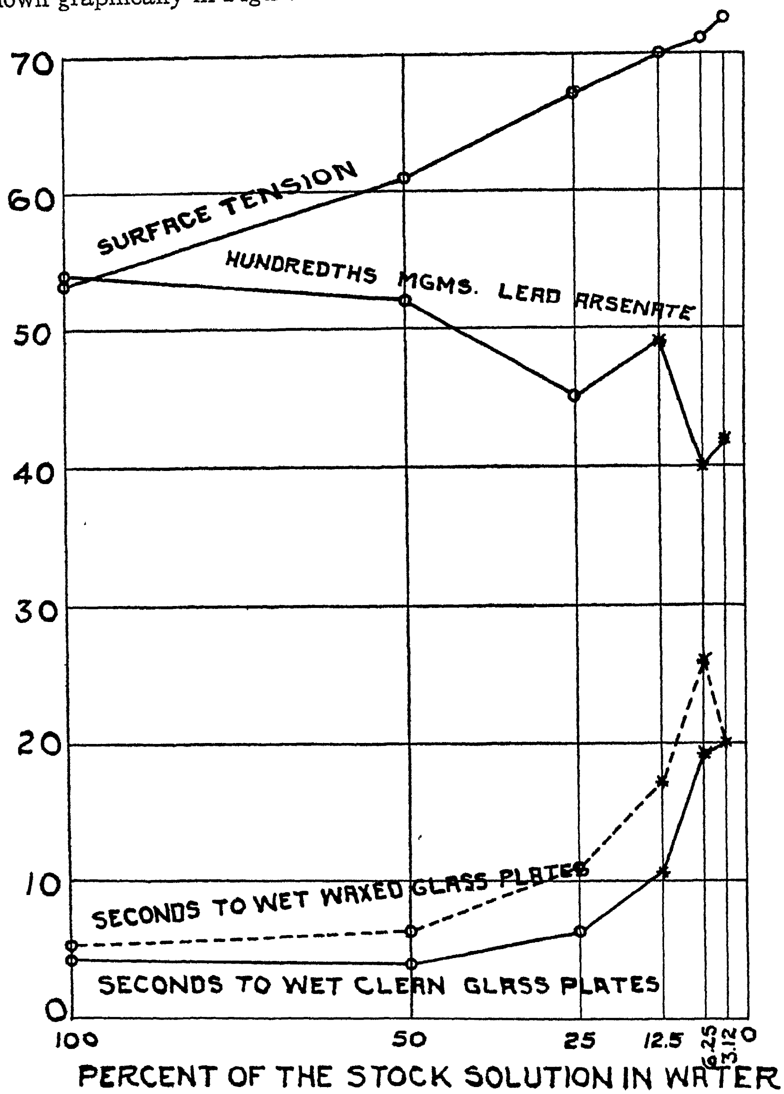


Fig. 27.—Showing the relation between the surface tension of a spray containing casein and lime as a spreader, the time to wet the sprayed surfaces and the quantity of lead arsenate deposited. Incomplete wetting is indicated by an *.

The surface tension is given in dynes per square centimeter, the lead arsenate deposited on the clean glass plates in hundredth of milligrams per 10 square inches and the time to wet 4 clean glass plates or 4 waxed

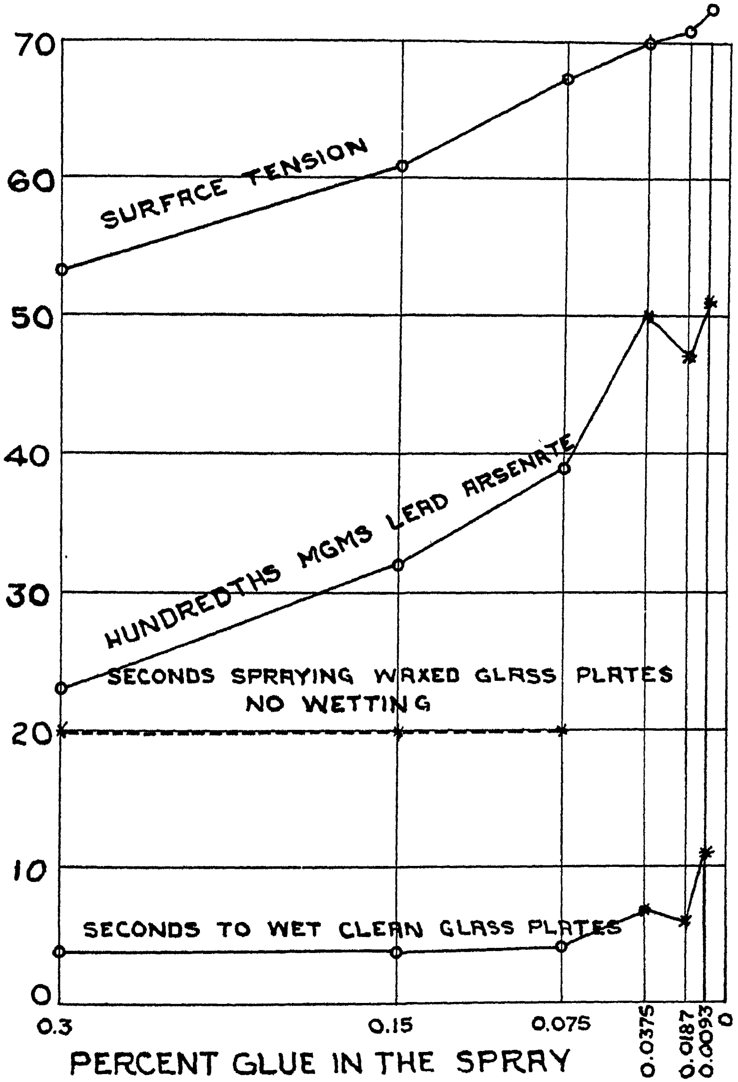


FIG. 28.—Showing the relation between the surface tension of a spray containing glue as a spreader, the time required to wet the sprayed surfaces, and the quantity of lead arsenate deposited. Incomplete wetting is indicated by an *.

glass plates in seconds. The quantity of lead arsenate on the waxed glass plates has not been charted. Incomplete wetting is indicated by an *.

In presenting the data given in Table number 1 and figures 24 to 29 it is desired to call particular attention to the similarity of the surface

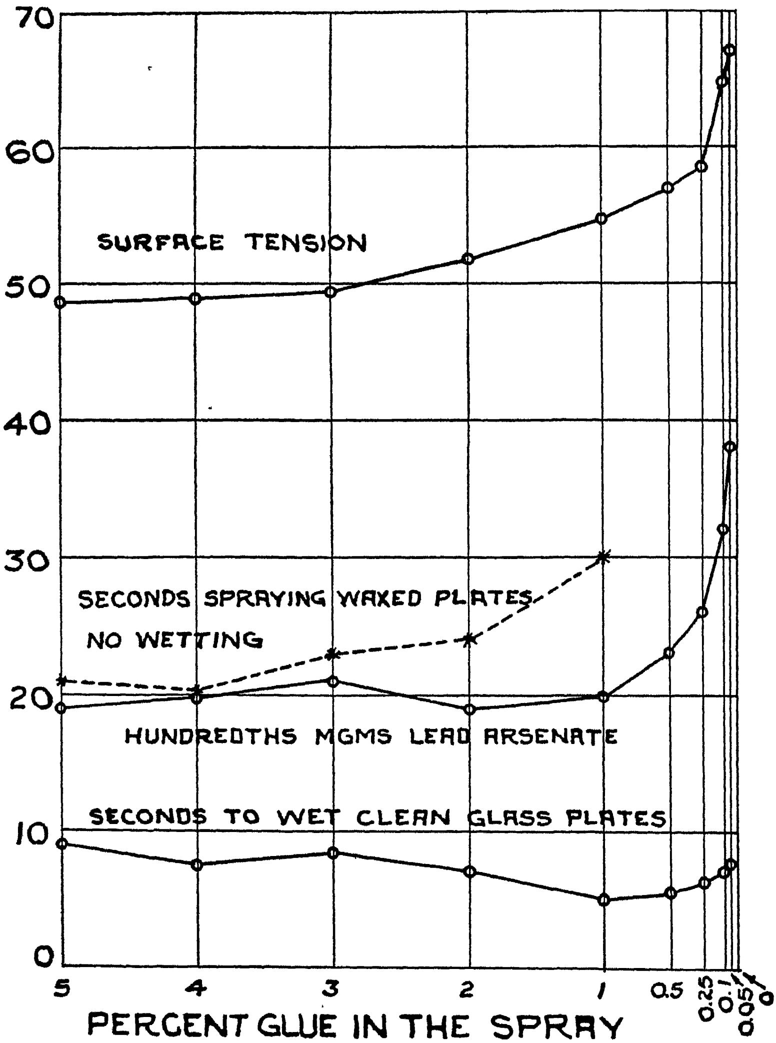


Fig. 29.—Showing the relation between the surface tension of a spray containing glue as a spreader, the time required to wet the sprayed surfaces, and the quantity of lead arsenate deposited. Incomplete wetting is indicated by an *.

tension curves; the curves showing the time required to wet clean glass plates and waxed glass plates and the relation existing between the time required to wet the clean glass plates and the quantity of lead arsenate deposited upon the sprayed surface.

Figures 24, 25 and 26, giving the data for powdered skim milk, flour and saponin, respectively, show a very similar surface tension curve for similar dilutions. The surface tensions of the spray material increased rather slowly until the spreader material in the spray was decreased to between 0.25 and 0.125 per cent, below which dilutions it began to increase much more rapidly. Figure 27 giving the data for casein plus lime, and figures 28 and 29 giving the data for glue are not directly comparable with the first three figures, since the spreader materials were not used at the same per cents. It will be noticed, however, that the surface tension increased rather rapidly for all dilutions used in figure number 27 (casein) and figure number 28 (glue). If the dilutions of casein and glue used in these two figures had been charted on the same basis as for figures 24 to 26 the curve would have been the same.

Figure 29 gives data for glue when used at considerably higher concentrations than any of the other spreader materials. The surface tension at the higher concentrations, i.e., from 5% to 2% is lower than for any of the other spreader materials. At 1.0% glue the surface tension is slightly higher than for similar concentrations of powdered skim milk, flour, saponin and casein.

The time required to wet the clean glass plates, and also the waxed glass plates, showed a definite relation to the surface tension of the spray material. As the surface tension increased the time required to wet the clean glass plates increased at almost the same rate. There is a considerable similarity in the curves showing the time required to wet clean glass plates when sprayed with powdered skim milk, flour, casein and glue when used at similar dilutions. Saponin wet the clean glass plates at the higher dilutions much easier than did the other spreader materials. The other materials, as is indicated by an * in the charts, would not wet at high dilutions, or if a film was formed during spraying this film rolled up and collected in drops after spraying was discontinued.

Figure 29 giving the data for glue at higher concentrations shows the effects of viscosity of the spray material on the rapidity of wetting. Glue at dilutions ranging from 5% to 2% inclusive had a lower surface tension than did glue at 1%, but the time required to wet the clean glass plates was slightly greater as the per cent of glue increased. At

TABLE 1. SHOWING THE RESULTS OF SPRAYING CLEAN GLASS PLATES AND WAX COATED GLASS PLATES WITH VARIOUS SPREADER MATERIALS PLUS LEAD ARSENATE, 1.8 GMS. TO 500 C.C. OF SPRAY.

Kind of Spreader Material	% Spreader in Diluted Spray	Surface Tension	Average Time in Seconds to Wet 4 Clean Glass Plates	Average Time in Seconds to Wet 4 Waxed Glass Plates	Average Mgms. Lead Arsenate per 10 Square Inches on Clean Glass Plates	Average Mgms. Lead Arsenate per 10 Square Inches on Waxed Glass Plates	Remarks
Powdered skim milk 10 parts; plus calcium hydroxide 1 part.	1.0	52.4	4.0	6.5	.38	.56	
	0.5	52.0	4.0	6.5	.46	.62	
	0.25	54.6	4.2	7.0	.53	.92	
	0.125	58.9	4.5	8.0	.64	1.06	
	0.062	60.4	5.0	12.0	.88	1.48	
	0.031	66.1	10.0	35.0	1.55	1.97	Waxed plates would not wet.
	0.015	70.3	14.0	—	.87	—	Waxed plates not sprayed.
	0.008	72.5	18.0	—	.77	—	Clean glass plates wet hard.
Flour 2 parts, calcium hydroxide 1 part.	1.0	51.7	4.0	5.0	.60	.63	
	0.5	53.8	4.5	6.0	.63	.72	
	0.25	56.6	4.9	8.2	.52	.71	
	0.125	59.6	6.5	17.5	.47	.71	Waxed plates would not wet.
	0.062	62.3	9.0	—	.58	—	Spray rolled up and drained off.
	0.031	67.3	14.6	—	.53	—	Some rolling up of spray on clean glass plates.
	0.015	72.5	22.0	—	.56	—	
Saponin	1.0	52.5	4.3	7.0	.53	.68	Clean glass plates and waxed glass plates wet good. Some spreading of spray liquid over surfaces after spraying was stopped.
	0.5	53.2	5.0	7.6	.38	.47	
	0.25	55.8	5.6	7.6	.44	.55	
	0.125	59.8	6.0	8.0	.46	.16	
	0.063	62.9	7.0	7.0	.49	.14	
	0.032	67.2	6.0	10.3	.44	.25	
	0.016	70.4	7.0	11.6	.66	.28	

Casein 2 gms.	0.2	53.2	4.3	5.3	.54	—	Good wetting of clean glass plates and waxed glass plates.
$Ca(OH)_2$ 4 gms. to 1000	0.1	60.9	4.0	6.3	.52	—	
c.c. allowed to stand for	0.05	67.3	6.3	11.0	.45	—	
3 hrs. before using, shaking thoroughly at intervals.	0.025	70.0	10.6	17.3	.49	—	Clean glass plates wet poorly. Waxed plates much harder.
	0.0125	71.0	19.3	26.0	.40	—	Waxed plates would not wet.
	0.0062	72.5	20.0	20.0	.42	—	Poor wetting of clean glass plates. On waxed plates spray collected in drops and drained off.
Powdered glue 3 grams to 1000 c.c.	0.3	53.2	3.8	20.0	.23	—	Clean glass plates wet easily.
	0.15	60.9	3.8	20.0	.32	—	Waxed glass plates would not wet.
	0.075	67.3	4.1	20.0	.39	—	
	0.037	70.0	6.3	—	.50	—	
	0.018	71.0	6.0	—	.47	—	
	0.0093	72.5	11.0	—	.51	—	Clean glass plates wet hard with some rolling up of film.
Powdered glue.	5.0	48.6	9.0	21.0	.19	—	Clean glass plates wet slow because of viscosity of spray.
	4.0	48.8	7.5	20.0	.20	—	
	3.0	49.3	8.5	23.0	.21	—	Waxed glass plates would not wet at any per cent.
	2.0	51.6	7.2	24.0	.19	—	
	1.0	54.7	5.2	30.0	.20	—	
	0.5	56.8	5.6	—	.23	—	Waxed plates not sprayed. Clean glass plates wet good at all dilutions.
	0.25	58.4	6.3	—	.26	—	
	0.10	64.8	7.2	—	.32	—	
	0.05	66.9	7.3	—	.38	—	

dilutions of glue less than 1% the time required to wet clean glass plates gradually increased as the surface tension increased.

The wax coated glass plates in all instances wet noticeably harder than did the clean glass plates. It will also be noticed that incomplete wetting, or no wetting at all, occurred at the higher dilutions of the spreader materials much quicker on wax coated glass plates than on clean glass plates. It should also be noticed that glue would not wet the wax coated glass plates even when used at concentrations as high as 5%. A film was formed during the process of spraying, which, however, collected in drops after spraying was discontinued. Saponin wet the waxed glass plates at the higher dilutions almost as easily as it wet the clean glass plates. The spray containing saponin, instead of collecting in drops after spraying was discontinued seemed to continue spreading until a smooth uniform film was formed.

The quantity of lead arsenate deposited upon the sprayed plates shows, wherever good wetting occurred, that in most cases it was directly proportional to the surface tension of the spray material or the time required to wet. As the surface tension increased, the quantity of lead arsenate deposited by spraying increased. Wherever incomplete wetting resulted, as is indicated by an *, the quantity of lead arsenate deposited by spraying was very erratic. Figure 27 giving the results of tests with casein does not conform to the general rule. This may be because casein was used in these tests at rather high dilutions, which dilutions were possibly approaching the "breaking point." Saponin at 1.0% also did not conform to the general rule, possibly because of the rather high viscosity of saponin at this dilution.

SUMMARY. The surface tension of spreader materials such as powdered skim milk plus lime, flour plus lime, saponin, casein plus lime, and glue when diluted so as to contain the same per cent of spreader material, does not differ greatly. The surface tensions rise somewhat slowly at dilutions containing 1.0% to 0.25% beyond which dilutions the surface tension increases at a much more rapid rate.

The time required to wet clean glass plates and waxed glass plates was proportional to the surface tension. Waxed glass plates required a longer time to wet and incomplete wetting resulted at higher dilutions quicker than on clean glass plates.

Glue did not wet the waxed glass plates at any of the concentrations tested, while saponin wet the waxed glass plates almost as readily as it wet the clean glass plates.

In general the quantity of lead arsenate deposited on the clean glass plates or the waxed glass plates increased as the surface tension of

the spray material increased or as the time required to wet the sprayed surface increased. It is evident that as the surface tension of the spray material increased, and the difficulty of wetting increased, a thicker film of spray liquid was required to give good wetting and that this thicker film of spray liquid resulted in a greater quantity of lead arsenate being deposited upon the sprayed surface.

The wetting ability of a spray material may be obtained by determining the time required to wet a uniform surface at different concentrations and different surfaces at the same concentration.

References Cited

1. Cooper, W. F. and Nuttall, W. H. The Theory of Wetting and the Determination of the Wetting Power of Dipping and Spraying Fluids Containing a Soap Basis. Jour. Agr. Sci. Vol. 7, Pt. 2, pp. 219–239, 1915.
2. Moore, William. Spreading and Adherence of Arsenical Sprays. Univ. of Minn. Agr. Expt. Station. Tech. Bulletin No. 2, pp. 1–50. 1921.
3. Woodman, R. M. The Physics of Spray Liquids. I—The Properties of Wetting and Spreading. Jour. Pomology and Horticultural Science. Vol. IV, pp. 38–58, 1925.
4. Stellwaag, F. Die Benetzungsfahigkeit flussiger Pflanzenschutzmittel und ihr Messbarkeit nach einem neuen Verfahren. (The Wetting Power of Liquid Media for Protecting Plants and Its Measureableness by a New Method.) Nachrichtenbl deutsch. Pflanzenschutzdienst, III, Nos. 11 and 12, pp. 85–86, 89–90, Berlin, December, 1923.
5. Stellwaag, (F.) Die Denetzungsfahigkeit flussiger Pflanzenschutzmittel und ihre direkte Messbarkeit nach einem neuen Verfahren. (The Wetting Power of Liquid Media for Protecting Plants and the Possibility of Measuring It directly by a New Method.) Zeitschr. angew. Ent. X, No. 1, pp. 163–176, 3 figs. Berlin, April 1924.
6. Hamilton, C. C. and Smith, C. M. A Colorimetric Method for Showing the Distribution and Quantity of Lead Arsenate Upon Sprayed and Dusted Surfaces. Jour. Econ. Entom., Vol. 18, No. 3, pp. 502–509. 1925.

THE EFFECT OF PYRETHRUM EXTRACT ON WIREWORMS AND UPON PLANTS INFESTED BY THEM[1]

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Abstract

A mixture of pyrethrum extract and soap can be used to destroy wireworms without injuring the plants on which they are feeding. Soils through which this mixture penetrates affect the toxicity of both the pyrethrum extract and the soap. This reduction in toxicity is least when the soil is composed exclusively of sand and increases as the clay component becomes larger.

[1]Paper of the Journal Series, New Jersey Agricultural Experiment Station, Department of Entomology.

Introduction

In view of the vast amount of study given to the problem of destroying wireworms by chemical means and the universal failure to find any treatment which can be used for their destruction (when found injuring plants) and leave their plant hosts unhurt, it has seemed worthwhile to make a preliminary report on the use of pyrethrum extract which, during the season of 1929, has been found to destroy wireworms without injuring the host plants upon which they were feeding. This discovery was first made by Robert G. Hepburn, a former Rutgers University student in agriculture, who was at that time and is now engaged in the production of vegetable crops in Essex County, New Jersey. Mr. Hepburn communicated his results to the County Agricultural Agent, Mr. R. E. Harman, and the County Agricultural Agent invited our attention to the matter.

The material utilized is known under the trade name of "Pyrethrol" the stock solution of which runs about five per cent oleoresin of pyrethrum and 45 per cent sodium oleate soap. In as much as the average amount of oleoresin obtained from a pound of pyrethrum flowers is 20 per cent of the dry weight of the flowers and pyrethrin I and II range from 1/3 to 1/2 per cent of the dry flowers, we have in this material pyrethrin I and II in the amount of 0.0833 to 0.125 per cent actual toxic principle. All the data submitted will be given from the standpoint of the oleoresin of pyrethrum, which can, with this basis, be readily transformed into actual toxic principle.

Field Studies. Experiments were set in the field on two different farms on which different soil conditions obtained. The following experiment was set on June 2nd and examined on June 3rd or approximately 24 hours later. One-fourth of a pint of the diluted "Pyrethrol" was poured around the base of each plant and this treatment wet the soil pretty thoroughly to a depth of about four inches. The paralyzed larvae were collected and placed in tin cans partially filled with soil taken from the field. Of the lot gathered on the Hepburn farm five of the paralyzed larvae died while of the lot gathered on the Young farm 7/8 of the paralyzed larvae treated with the old "Pyrethrol" died and all of the paralyzed larvae from the new "Pyrethrol" treatment died. The results of this experiment are set forth in Table 1.

This table shows that when dealing with new or fresh "Pyrethrol" at a dilution with water of 1 to 50 a high per cent of the larvae about the base of the infested plants was destroyed because most of the paralyzed larvae eventually died.

TABLE 1. FIELD STUDY OF THE EFFECT OF PYRETHRUM EXTRACT AND SODIUM OLEATE ON WIREWORMS.

Material Used Nature	Amount	Percentage Oleoresin in Stock Solution	Percentage Soap in Stock Solution	Dilution employed	Percentage Oleoresin in Mixture Ready to Use	Percentage Soap in Mixture Ready to Use	Date of Treatment	Date of Examination	Wireworms Found Total	No. Paralyzed	No. Alive	No. Dead	Per cent Killed
Hepburn Farm—Heavy Clay Soil													
Pyrethrol	¼ pt. to 7.0 sq. in.	5	45	1–100	0.05	0.45	6/2, '29	6/3, '29	30	2	27	1	3.7
Pyrethrol	"	5	45	1–100	0.05	0.45	"	"	19	3	15	1	5.2
Pyrethrol	"	5	45	1– 75	0.066	0.6	"	"	8	3	4	1	12.5
Pyrethrol	"	5	45	1– 75	0.066	0.6	"	"	13	3	9	1	7.6
Insecto	"	40	30	1– 75	0.42	0.4	"	"	27	1	25	1	3.7
Insecto	"	40	30	1– 75	0.52	0.4	"	"	12	2	9	1	8.3
Insecto	"	40	30	1– 50	0.8	0.6	"	"	11	1	9	1	9.0
Insecto	"	40	30	1– 50	0.8	0.6	"	"	12	3	8	1	8.3
Young Farm—Light Rather Sandy Clay Loam													
Pyrethrol 1 year old	"	5	45	1– 75	0.06	0.6	6/2, '29	6/3, '29	21	5	9	7	33.3
"	"	5	45	1– 75	0.06	0.6	"	"	14	0	6	8	57.0
"	"	5	45	1– 50	0.1	0.9	"	"	10	3	2	5	50.0
Pyrethrol Fresh	"	5	45	1– 50	0.1	0.9	"	"	17	0	5	12	70.5
"	"	5	45	1– 50	0.1	0.9	"	"	14	3	0	11	78.5
"	"	5	45	1– 50	0.1	0.9	"	"	12	2	1	9	75.0

The host plants experiencing this treatment included cabbage, sweet corn, horse radish, lima beans and string beans. These plants were kept in close observation and no appreciable damage chargeable to the treatments was suffered by them.

LABORATORY STUDIES. In order to get figures from controlled experiments a laboratory study of the effect of "Pyrethrol" was set up. Six clay flower pots, five inches in diameter at the top and six inches deep, were used. Each pot was filled with sassafras loam soil and transversely divided into one inch chambers by discs of 16 mesh wire gauze. In each chamber except the lowest three wireworms and three grains of corn were planted. The lowest inch received no wireworms nor corn, making 15 worms per pot. One-fourth of a pint of "Pyrethrol" mixture with water was poured upon the surface of each pot, the actual surface area of which was approximately 19.625 square inches while the surface of the soil receiving the same treatment in the field was only about 7.0686 square inches. The field treatment, therefore, received about 2.7 times as much material per square inch as did the pot treatments. This experiment was set up on June 19, 1929 and was examined 18 hours later. A careful check on recovery was kept. At the time of examination the worms were either dead or alive. There were no cases of paralysis, that effect having disappeared before the examinations were made. The results of this study are set forth in Table 2.

This table shows 1 to 25 as effective as 1 to 15 and indicates that the kill is, in general, proportional to the strength used except where the strength of solution becomes greater than the optimum.

At this stage of the investigation it became obvious that, in as much as the possibility of destroying wireworms with pyrethrum extract and soap seemed to have been demonstrated by the preceding experiments, the direct effect of this mixture upon the worms without soil interference should be determined. It also seemed obvious that following this determination of direct effect should come a study of the relation of the soil, in which the wireworms normally live, to the effect of this mixture upon the worms themselves.

Attacking the first phase of this problem individual wireworms were enclosed in watch-glass moist-chambers and a drop of pyrethrum extract and soap mixture was placed upon the jaws of each. Almost instantly after the drop touched the jaws it spread over the entire surface of the insect. This phenomenon is one with which the writer has been familiar for several years. The interfacial tension between the integument of wireworms and distilled water is almost nil. A

TABLE 2. LABORATORY STUDY OF THE EFFECT OF PYRETHRUM EXTRACT AND SODIUM OLEATE ON WIREWORMS.

Treatment Nature	Treatment Amount	Percentage Oleoresin, Stock Solution	Percentage Soap, Stock Solution	Dilution With Water	Percentage Oleoresin in Diluted Mixture	Percentage Soap in Diluted Mixture	Total	Alive	Dead	Wireworms Per cent Dead	Depth of Dead
Pyrethrol Fresh	¼ pt. to 19.6 sq. in.	5	45	1– 15	0.33	3.0	15	11	4	26.6	First 2 inches
Pyrethrol Fresh	"	5	45	1– 25	0.2	1.4	15	11	4	26.6	First 1 inch and 2nd inch
"	"	5	45	1– 50	0.1	0.9	15	13	2	13.3	Fifth inch
"	"	5	45	1– 75	0.066	0.6	15	14	1		Mechanical injury
"	"	5	45	1–100	0.05	0.45	15	12	2	13.3	First and second inches
Check							15	15	0	0.0	

TABLE 3. LABORATORY STUDY OF PYRETHRUM EXTRACT AGAINST INDIVIDUAL WIREWORMS TO LEARN THE TOXIC DOSAGE.

Date of Experiment	Worm Number	Worm Size—Length in Inches	Material Used	Per cent Oleoresin	Per cent Soap	Dilution With Water	Per cent Oleoresin in Used Mixture	Per cent Soap in Used Mixture	Minutes to Paralyzed Condition	Hours to Death	Remarks
6/25, '29	1	5/8	Pyrethrol	5.0	45.0	1 to 10	0.5	4.5	1.0	18.0	
6/25, '29	2	5/8	"	5.0	45.0	1 to 15	0.33	3.0	1.0	18.0	
6/25, '29	3	5/8	"	5.0	45.0	1 to 25	0.20	1.4	3.0		Alive at 24 hours
6/25, '29	4	5/8	"	5.0	45.0	1 to 50	0.1	0.9	10.0		Alive at 24 hours
6/25, '29	5	5/8	"	5.0	45.0	1 to 75	0.066	0.6	15.0		Alive at 24 hours
6/25, '29	6	5/8	"	5.0	45.0	1 to 100	0.05	0.45	20.0		Alive at 24 hours
6/25, '29	7		Check								Alive at 24 hours
6/27, '29	8	5/8	Pyrethrol	5.0	45.0	1 to 10	0.5	4.5	1.0	18.0	
6/27, '29	9	5/8	"	5.0	45.0	1 to 15	0.33	3.0	1.0	18.0	
6/27, '29	10	5/8	"	5.0	45.0	1 to 25	0.20	1.4	5.0	24.0	
6/27, '29	11	5/8	"	5.0	45.0	1 to 50	0.1	0.9	15.0		Alive at 24 hours
6/27, '29	12	5/8	"	5.0	45.0	1 to 75	0.066	0.6	20.0		Alive at 24 hours
6/27, '29	13	5/8	"	5.0	45.0	1 to 100	0.05	0.45	30.0		Alive at 24 hours
6/27, '29	14		Check								Alive at 24 hours

drop of distilled water placed upon the jaws of the wireworm instantly envelops the worm's entire body. The results of this study are set forth in Table 3.

This table shows that a concentration of 1 to 25 is apparently necessary to produce death and that a concentration of 1 to 15 is more certain to accomplish this result. It must be remembered, however, that the film of solution covering the body of the wireworm was extremely thin and that only a very small portion of that film could be expected to penetrate the spiracles. As a matter of fact the film probably ranged from about 3 to 10 microns in thickness.

Now comes the study of the relation of the soil factor to the effect of this material upon the worms. The soils used in this study were sassafras loam which were not as heavy as the clay soils of the Hepburn place nor as light as the sandy loam of the Young farm. These soils were stabilized to dryness before being used.

It was thought well first to determine the effect of soil filtration upon the surface tension of the mixture and, of course, changes in surface tension through filtration should be chargeable to the removal of soap. Table 4 sets forth the results.

TABLE 4. STUDY OF THE EFFECT OF FILTERING PYRETHRUM EXTRACT THROUGH SOIL ON SURFACE TENSION OF AQUEOUS SOLUTION

Mixture of Pyrethrol and Water	Per cent Oleoresin	Per cent Soap	Inches of Soil Through Which Solution Poured	Surface Tension in Dynes per Centimeter
1 to 15	0.33	3.0	0.0	29.86
1 to 15	0.33	3.0	4.0	40.94
1 to 15	0.33	3.0	6.0	49.2
1 to 15	0.33	3.0	7.0	51.92
1 to 15	0.33	3.0	10.0	59.4
Distilled water				76.7

This table shows a steady increase in surface tension as the mixture was filtered through the sassafras loam soil. Starting with a surface tension of 29.86 dynes per centimeter it rose, when filtered through 10 inches of sassafras loam soil to 59.4 dynes. Obviously, very considerable amounts of soap are removed in this process.

The next step was to find out whether this reduction in surface tension had any reduction in toxicity correlated with it. To determine this matter the pyrethrum and water mixture was filtered through various depths of soil and a certain amount of liquid caught, 51 cc in each case. In order to drive this mixture through in a limited time after it had soaked into the soil it was followed by water in measured amounts. The toxicity of the filtrate was tried against *Aphis rumicis*. The results are set forth in Table 5.

TABLE 5. STUDY OF THE EFFECT OF FILTERING PYRETHRUM EXTRACT THROUGH SOIL ON TOXICITY OF THE ACTIVE AGENTS.

Mixture of Pyrethrol and Water	Per cent of Oleoresin	Per cent of Soap	Inches of Soil Through Which Solution Poured	Amount of Solution Poured in Soil	Amount of Water Added in cc.	Amount Solution Collected in cc.	Surface Tension of Filtrate in Dynes per Centimeter	Per cent of *Aphis rumicis* Killed by Spraying With Filtrate
1 to 15	0.33	3.0	0.0				29.86	100.0
1 to 15	0.33	3.0	4.0	51.0	102.0	51.0	40.94	38.2
1 to 15	0.33	3.0	6.0	51.0	102.0	51.0	49.2	21.2
1 to 15	0.33	3.0	7.0	51.0	102.0	51.0	51.92	20.0
1 to 15	0.33	3.0	10.0	51.0	204.0	51.0	59.4	17.8

TABLE 6. STUDY OF THE COMPARATIVE TOXIC EFFECT OF SODIUM OLEATE AND PYRETHRUM EXTRACT AFTER COMBINED SOLUTION HAS BEEN FILTERED THROUGH SASSAFRAS LOAM SOIL.

Mixture of Pyrethrol and Water	Per cent of Oleoresin	Per cent of Soap	Surface Tension	Inches of Soil Through Which Solution Poured	Surface Tension of Filtrate	Soap Added	Surface Tension After Adding Soap	Percentage of *Aphis rumicis* Killed	Percentage of *Aphis rumicis* Killed Less Percentage Killed by Water
1 to 200	0.025	0.225	30.8	4	40.9	No	40.9	27.0	13.3
					41.0	Yes	31.3	62.5	48.8
1 to 200	0.025	0.225	30.8	6	43.3	No	43.3	47.5	33.8
					43.4	Yes	32.3	76.9	63.2
1 to 200	0.025	0.225	30.8	7	43.3	No	43.3	18.0	0.3
					43.4	Yes	32.8	72.0	58.3
1 to 200	0.025	0.225	30.8	10	45.8	No	45.8	4.6	
					45.8	Yes	31.3	42.7	29 0
1 to 200	0 025	0.225	30.8	0			30.8	79.3	65.6
Water alone								13.7	

TABLE 7. STUDY OF THE EFFECT OF FILTERING PYRETHRUM SOAP SOLUTION THROUGH SOIL (WASHED QUARTZ SAND) UPON THE TOXICITY OF THE SOLUTION.

Mixture of Pyrethrol and Water	Percentage Oleoresin	Percentage Soap	Surface Tension	Depth of Soil in Inches Through Which Solution Passes	Surface Tension of Filtrate	Percentage of *Aphis rumicis* Killed
1 to 15	0.33	3.0	30.8	0.0	30.8	100.0
1 to 15	0.33	3.0	30.8	4.0	30.8	100.0
1 to 15	0.33	3.0	30.8	6.0	30.8	100.0
1 to 15	0.33	3.0	30.8	7.0	30.8	100.0
1 to 15	0.33	3.0	30.8	10.0	30.8	100.0
Water alone					70.0	0.0

This table shows a very rapid diminution of toxicity for the first four inches and a slow but steady diminution in toxicity from that point on.

Thus far there has been no attempt to separate the effect of filtration upon the pyrethrum extract and upon the soap. This phase of the question was next considered. The combined material was filtered through sassafras loam soil as before without adding any water to force it through. One-half of the filtrate in each case received an additional soap to bring the surface tension back approximately to that at which the start was made. The other half was tested as it came through. The results of this study are set forth in Table 6.

This table shows that toxicity of the soap is reduced by filtering the solutions through soil because replacement of lost soap is followed by increased kill. This table shows that toxicity of the pyrethrum extract is also reduced by the process because the addition of the requisite soap to bring the surface tension back to about the original exhibits a kill at the 10 inch level of less than ½ of the percentage of lice destroyed by the "Pyrethrol" and water solution before it was filtered through soil at all.

Thus far the laboratory soil study has been concerned on one type of soil only. At this point it seemed advisable to try a soil in which the removal of soap and of pyrethrum extract would have to occur through adsorption only. Accordingly, a soil composed of washed quartz sand was employed and the tests were carried out along the same lines as before. The results are set forth in Table 7.

This table shows that filtration through even 10 inches of washed quartz sand reduces neither the surface tension nor the toxicity of the "Pyrethrol" and water mixture. Obviously then the removal of soap and pyrethrum extract is not a matter of physical adsorption when one is dealing with a soil composed of ordinary crystalline materials. In connection with this conclusion it is worthwhile remembering that the soil on the Young farm, as shown in Table 1 was a sandy clay loam, and that the toxic effects of material at that place were uniformly better than in the heavy clay soil of the Hepburn farm.

Discussion and Conclusions

Apparently for the first time in the history of fighting wireworms a material has been found which can be applied to the plants that are being injured, the worms destroyed and the plants left unhurt. The

plants tested covered a considerable range of the vegetables that are likely to be infested with wireworms and the absence of injury on those tested gives one reason to hope that this range is very much wider than the present tests have covered.

Exactly what part soap, on the one hand, and pyrethrum extract, on the other, play in the efficiency of this mixture has not been determined in the course of this study, but it has been indicated that both are important. In Table 6 reduction in soap content through soil filtration is accompanied by reduction in toxicity and replacement of soap content brings back toxicity but never to its original point. This shows that pyrethrum extract is an important toxic agent in the combination. Again in Table 6 filtration through six inches of soil gives a filtrate 33.8 per cent killing power. Replacement of the lost soap in the same filtrate gives to that filtrate a killing power of 63.2 per cent. This demonstrates that soap is an important factor in toxicity. It is, of course, recognized with making the above statements that the toxicity is being measured in Table 6 against *Aphis rumicis* and not against wireworms but it must be remembered also that we are dealing with pyrethrum extract and soap mixtures that had been filtered through soil and consequently with a mixture which must be expected to affect the wireworm. The writer is sorry that he failed, in the course of this study to try soap alone in the work comprehended in Table 3 where it should probably have come in.

It is indicated that filtration through soil reduces the toxicity of both the soap and the pyrethrum extract and that the greater the extent to which the soil is composed of clay the greater is the reduction in this toxicity. It has been indicated that physical adsorption is not alone responsible for this reduction in toxicity, although physical adsorption in the more collodial materials, such as clay, would be apt to be a much more important factor.

It has been shown in Table 2 that the reduction in toxicity of this mixture to wireworms is somewhat proportional to the depth of soil through which it is filtered and that it is most toxic in the upper layers. It is indicated by these studies in general that the toxicity reduction in the first four inches is not a particularly serious matter even where the soils are of a clay type. Other data in possession of the writer indicate that the adding of water for the purpose of driving the solution deeper results in dilution of the material and in reduction of toxicity from that standpoint. These data indicate that if deeper penetration is desired more of the mixture should be applied to the surface.

TOXICITY OF PYRETHRUM VAPORS TO INSECTS

By Dr. JOSEPH M. GINSBURG, *New Brunswick, N. J.*

(Withdrawn for publication elsewhere)

Friday Afternoon, November 22, 1929

THE EFFECT OF TALC ON THE OVIPOSITION OF A TRYPETID[1]

By ROBERT C. BURDETTE, *Associate Entomologist, New Jersey Agricultural Experiment Station*

ABSTRACT

Talc when dusted on pepper plants materially reduced the oviposition of the pepper maggot fly, *Spilographa electa*, in the pepper fruit. The talc acted on the fly either as a repellent or as a mechanical barrier to oviposition. Failure to maintain a coating of the talc on the plants when the fly is on the wing results in a prompt increased infestation in the peppers.

The pepper maggot (*Spilographa electa* Say) has been of economic importance to the pepper crop in New Jersey for the last 12 years. All measures carried out and looking toward a control of this fly until the present year have proven of no apparent economic value. The only exception to this general rule is the practice of picking and marketing peppers green. This is, of course, a community measure and one very difficult to introduce into successful practice.

During the winter of 1928–1929 the question of the possibility of using mechanical barriers to prevent this insect from oviposition was given consideration. Headlee[2] had shown that the larvae of the bean weevil (*Bruchus obtectus* Say.) could be prevented from entering the dried bean seed by coating the seed thinly with a layer of colloidal clay dust. Driggers[3] had shown that the Oriental peach moth larvae could be destroyed to the extent of more than 90 per cent if the foliage and twigs over which they crawled were thinly coated with talc or mica dust. In both instances the dusts covered the holdfasts of the insects and prevented them from gripping the surface on which they were working with sufficient power to carry on their normal processes. In the case of the bean weevil larvae the holdfasts became so coated that the insect was unable to grip the bean surface with sufficient power to gnaw its way through the skin. In the case of the Oriental

[1]Paper of the Journal Series, New Jersey Agricultural Experiment Station, Department of Entomology.

[2]Headlee, T. J., Report of the Department of Entomology, N. J. Agricultural Expt. Station, for the year ending June 30, 1923. P. 265–268.

[3]Driggers, B. F., Journal Economic Entomology, V. 22, No. 2, pp. 327–334.

peach moth the larval holdfasts were so coated that it was unable to crawl on the surface of the foliage or twigs, slipped and fell to the ground and could not get back on the tree. These facts led the writer to wonder whether dusts would not act in a similar fashion with the pepper maggot adult.

Two experiments were tried. The first was concerned with the common house fly (*Musca domestica*) and was undertaken because the pepper maggot fly was not at that time available. The inside of a large glass bell jar was dusted with talc. The adult house flies introduced into this bell jar were totally unable to crawl up the sides or adhere to the ceiling. Examination of the feet of these flies showed that the pulvilli were completely coated with the talc dust. As soon as practical thereafter the writer caused early emergence of the pepper maggot fly and tested these flies in the same way. They, too, were totally unable to crawl up the sides or on the ceiling of the dusted bell jar while in a similar container without talc dust they were perfectly able to crawl over the sides and adhere to the ceiling. Examination of their pulvilli showed that they were completely coated with the talc dust.

It is known that the pepper maggot fly must be able to grip the surface of the young pepper with sufficient stregnth to drive its ovipositor through the epidermis of the pepper. It was thought, therefore, likely that if the young pepper at the time it was especially susceptible to oviposition was kept coated with talc dust the pepper maggot fly would be unable to insert her eggs through its skin. When the season of 1929 opened and the flies appeared a number of field experiments were undertaken to test this idea.

FIELD STUDIES ON TALC DUST AGAINST THE PEPPER MAGGOT. A field of 31 rows was dusted with talc to note the effect of the material on the flies. The first dust was applied on July 16th five days after the flies were observed ovipositing in the young peppers. The 10th, 21st and 31st rows were left undusted as a check. When the dusting was completed, careful checking of the rows where the dust was applied showed no flies resting on the plants or young peppers. When the rows that were left undusted were checked, a very large number of flies were found. As high as five flies were captured at one time on a single plant. After observing this condition, a check of the infestation of the field was made.

The determination of the infestation of a pepper field was made by opening peppers ranging from ½ inch to 1¼ inches in diameter and noting whether eggs were present or not. This size pepper is preferred by the pepper fly for oviposition. When the peppers become larger than 1½

inches in diameter eggs are very rarely deposited in them. The growth of the young peppers is very rapid, so that a check of the field can be made every two weeks on a new lot of young peppers. This method allows one to follow the egg infestation of the peppers as the season progresses. The maximum number of flies are found in the field from about July 15 to August 5. The number of flies and eggs diminish until about August 20 when none can be found in the field.

TABLE 1. COUNT OF INJURED PEPPERS ON CHECK BLOCK AND TALC DUSTED BLOCK AT MR. BURLEW'S FIELD.

Type of Injury	Date of Checking	Date of Dusting	Total Peppers Counted		No. Peppers Injured		Per cent Peppers Injured	
			Check	Dust	Check	Dust	Check	Dust
Egg puncture	July 16	July 16, 23	27	53	13	15	50	28
Egg puncture	July 27		63	76	31	4	49.2	5.2
		July 29						
Egg puncture	Aug. 9	Aug. 2, 8	63	120	12	4	19	3.3
Egg puncture	Aug. 23		30	50	1	0	3.3	0.0
Larva	Aug. 29		65	120	23	2	35	1.7
Larva	Sept. 10		125	127	19	0	15.5	0.0
Larva	Sept. 25			52		0		0.0

Table 1 gives the results of the use of talc on this field. The 28 dusted rows showed 28 per cent infestation on the day the dust was applied, while the three rows left undusted showed 50 per cent infestation. The weather for the next seven days was cloudy with a little rain. Where the dust had been used, no flies were found, while large numbers were found on the undusted rows. The block was redusted on July 23rd. A check of the infestation was made on July 27th. The undusted rows showed 49.2 per cent infestation and the dusted rows 5 per cent infestation. The field was redusted on July 29th. A rain washed the dust off on August 1st and it was then redusted on August 2nd. The last dust was applied on August 8th. A check of the field on August 9th, showed only 3.33 per cent infestation on the dusted block and 19 per cent infestation on the undusted rows. Another check of the field was made for eggs on August 23rd. No eggs were found on the dust block and only one egg was found in the undusted rows.

The peppers in this field were of the bull nose variety and were allowed to redden in the field. On August 29th, a check of the peppers for maggots was made. In the dusted block, only 1.7 per cent of the peppers showed maggots while the undusted rows showed 35 per cent of the peppers infested with maggots. A small picking of the peppers was made at this time. On September 10th another check of the field was made. No maggots were found in the peppers from the dusted block and 15.5 per cent of the peppers from the undusted rows had maggots in them.

TABLE 2. COUNT OF PEPPERS WITH EGGS ON TALC DUSTED BLOCK AND CHECK BLOCK AT MR. ADLER'S FARM.

Date of Checking	Date of Dustings	Total Peppers Counted		No. Peppers With Eggs		Per cent Peppers With Eggs	
		Check	Dust	Check	Dust	Check	Dust
July 18	July 18	31	35	2	1	6.45	2.8
July 27	July 22	40	30	2	0	5.0	0
August 10		70	60	3	4	4.3	6.67
August 24		50	50	0	0	0.0	0.0

Table 2 gives the results of talc dust on a second field of about one acre of peppers of the bull nose variety. This field, which had 50 rows, was divided into two equal parts; one part was dusted and the other left as a check.

Upon checking the blocks July 18th just before dusting, the block not to be dusted showed 6.4 per cent infestation, while the block to be dusted showed 2.8 per cent infestation. Another application was made on July 22nd. A check of the blocks on July 27th, showed an infestation of 5 per cent in the undusted block and 0 per cent in the dusted. No more dust was applied to this block because the plants were heavily infested with aphis. The secretions from the aphis and the talc made a very messy combination on the peppers as they were being picked for market at this time. A check on the blocks was made on August 10th, the undusted block showed 4.3 per cent infestation and the block where the dust had been applied earlier showed 6.7 per cent infestation. The infestation immediately jumped up when dusting was stopped.

TABLE 3. COUNT OF INJURED PEPPERS ON TALC DUSTED AND UNDUSTED BLOCKS AT MR. CEVASCO'S FARM

Type of Injury	Date of Checking	Date of Dusting	Total Peppers Counted		No. Peppers Injured		Per cent Peppers Injured	
			Check	Dust	Check	Dust	Check	Dust
Eggs in peppers	July 17	July 17 July 24	59	58	29	28	58.0	48.3
Eggs in peppers	July 27	July 27 Aug. 2, 5	54	50	25	10	46.0	20.0
Eggs in peppers	Aug. 9		75	100	11	1	14.7	1.0
Eggs in peppers	Aug. 23		50	83	0	0	0	0
Larvae	Sept. 4		50	60	22	12	44.0	20.0

Table 3 gives the results of the talc dust on a third field containing about three-quarters of an acre. One-half of this field was left undusted as a check. This field was first checked and then dusted on July 17th. The check at this time showed 58 per cent infestation on the block not to be dusted and 48 per cent on the block to be dusted. A second dusting was made on July 24. A check of the infestation was made on July 27th,

the dusted block showed 20 per cent and the undusted 46 per cent. The block was redusted on July 27, August 2 and a last dust on August 5th. A check of the field on August 10th showed the undusted block to be 14.7 per cent infested, while the dusted block showed only one per cent. A check on August 23rd showed no infestation of the peppers on either block. A check of the maggots in the peppers was made on September 4th. The undusted block showed 44 per cent infestation and the dusted block 20 per cent. It is to be noted here that the per cent maggot infestation is very similar to the per cent egg infestation when the field was checked after two dust applications. No further checks were made on this field as the peppers were picked green.

TABLE 4. COUNT OF INJURED PEPPERS ON TALC DUSTED BLOCK AT MR. OERTEL'S FARM

Type of Injury	Date of Checking	Date of Dusting	Total Peppers Counted	No. Peppers Injured	Per cent Peppers Injured
Eggs in peppers	No peppers on plants	July 16, July 24, 27, 30, Aug. 2	—	–	—
Eggs in peppers	Aug. 5	Aug. 7, 15	21	0	0
Eggs in peppers	Aug. 16		40	0	0
Larvae in peppers	Sept. 3		85	2	2.35
Larvae in peppers	Sept. 12		322	3	0.93
Larvae in peppers	Sept. 25		28	0	0.0

Table 4 gives the results of talc on a three row patch of peppers that were just blossoming. The peppers on this farm were completely destroyed the previous year. A complete coating of the peppers with talc was maintained. The dust was applied on July 16th, 24th, 27th, 30th and August 2nd. A check of the peppers on August 5th showed no eggs as having been deposited. Two more applications were made on August 7th and 15th. The peppers were again checked on August 16th with no egg deposition being found. On September 3rd, 85 peppers were picked, only two had maggots in them showing 2.4 per cent infestation. On September 12th, 322 peppers were picked and only three had maggots in them, showing 0.93 per cent infestation. More than half of this block was of the cheese or tomato variety of peppers, which is the variety preferred by the pepper fly for oviposition.

TABLE 5. COUNT OF PEPPERS WITH EGGS ON TALC DUSTED BLOCK AND CHECK BLOCK ON MR. MORRILL'S FARM

Date of Checking	Date of Dusting	Total Peppers Counted		Total Peppers With Eggs		Per cent Peppers With Eggs	
		Check	Dust	Check	Dust	Check	Dust
August 1	August 1, 2, and 7	17	22	9	12	53.0	54.5
August 13	August 15	30	60	9	3	30.0	5.0
August 23		12	35	1	0	8.33	0.0

Table 5 gives the results of talc dust on a fifth field. All of this field was dusted but two rows. The field was checked on August 1st. The part to be dusted showed 53 per cent infestation and the check rows showed 54.5 per cent infestation. The dust was then applied in the morning of August 1st and rain washed most of it off in the afternoon. The field was redusted on August 2nd and again on August 7th. A check of the infestation was made on August 13th. The check rows showed 30 per cent infestation and the dusted part only 5 per cent. The field was again dusted on August 15th. Another check was made on August 23rd. The check rows showed 8.3 per cent infestation while the dusted rows showed no infestation. No further checks were made on this field.

Discussion and Conclusions. The results of the field studies, as set forth in the preceding pages, seem to indicate clearly that the pepper maggot fly is unable to oviposit where a thin film of talc dust is present upon the pepper fruit at the time that this fruit is attractive for egg laying. Furthermore, these studies seem to indicate that the pepper maggot fly does not like to alight upon or crawl upon plants covered with talc dust. This is probably due to the coating of the pulvilli with this dust and thereby rendering the foothold of the insect uncertain. Furthermore, it is entirely possible that the fly is totally unable to penetrate the skin of the pepper and lay its egg because it is unable to grip the pepper fruit surface with sufficient strength. There is no question that it alights and is occasionally found on pepper plants that have been dusted with the talc dust. In spite of this fact, however, the pepper maggot flies do not seem to have been able, under field conditions, to deposit any considerable number of eggs.

The field work also shows that any failure to maintain a coating of dust on the pepper plants when the pepper fruit is in its attractive stage and the fly is on the wing results in prompt increased infestation in the pepper. It is, therefore, necessary in trying to effect protection of the pepper fruit from the pepper maggot fly that the coating of dust shall be maintained while the fruit is in its susceptible condition and the fly is on the wing. This process involves on the average, it is believed, the application of about ten dustings during the season at a cost of approximately \$6 per acre divided into cost of material \$2, and cost of application \$4.

The degree of success obtained will be proportional to the degree of completeness with which the talc dust is maintained upon the pepper plant during the period when the fruit is susceptible and the fly is on the wing.

PRESENT DISTRIBUTION OF THE JAPANESE BEETLE (*POPILLIA JAPONICA* NEWM.) AND THE ASIATIC BEETLES (*ASERICA CASTANEA* ARROW, *ANOMALA ORIENTALIS*) IN THE UNITED STATES

By C. H. Hadley, *Camden, N. J.*

(Withdrawn for publication elsewhere)

THE USE OF TRAPS AS A CONTROL FOR THE JAPANESE BEETLE

By O. K. Courtney, *U. S. Dept. of Agriculture, Camden, N. J.*

(Withdrawn for publication later)

A NEMATODE PARASITE OF THE JAPANESE BEETLE

By R. W. Glaser, *Princeton, N. J.*

(Withdrawn for publication later)

THE ESTABLISHMENT AND COLONIZATION OF *TIPHIA POPILLIAVORA*, A PARASITE OF THE JAPANESE BEETLE[1]

By J. L. King and J. K. Holloway, *U. S. Dept. of Agriculture, Bureau of Entomology*[2]

Abstract

Tiphia popilliavora was introduced from Japan and established in the beetle infested area in 1921–23. The present mother colony at Riverton, New Jersey, was started at that time with approximately 50 females. Definite recovery was made in 1926 and at that time the species was found within an area of approximately four acres. This season, 1929, the colonies had increased covering an area of 3.5 square miles. Within this area, thousands of females and males were seen feeding on the flowers of wild carrot.

In 1927 field collections of females were started, resulting in 11 subcolonies of 100 ♀ each. In 1928 a check showed that eight of these had become established. With this precedent some 33 colonies were put out in 1928.

During 1929, Tiphia were very abundant in the mother colony center and it was determined to place as many colonies in the field as could be obtained, Seven col-

[1]Contribution No. 67. U. S. Department of Agriculture, Japanese Beetle Laboratory, Moorestown, New Jersey.

[2]The writers wish to acknowledge with appreciation the work of many contributors during the early history of this species. Special acknowledgment is due Mr. R. W. Burrell, Mr. J. W. Balock, and Mr. R. T. White, of this Laboratory, who assisted materially in the colonization work of 1929, and to Mr. H. C. Hallock for the work on Long Island, N. Y.

lectors working during a 17 day collecting period were able to collect 10,100 females. These were placed in 101 colonies of 100 females each on the margins of the heavily infested beetle area. At the present time there are 134 colony centers established throughout the infested region.

A small number of tests releasements have also been made in the areas infested with *Phyllopertha orientalis* on Long Island, New York, and New Haven, Connecticut.

Tiphia popilliavora Roh. is a wasp-like parasite of the larval stage of the Japanese beetle, *Popillia japonica*. This species was first found at Koiwai, Japan, in August, 1920.[3] Investigations have revealed the fact that though this species is abundant locally in Japan it has a wide distribution and occurs also in Korea and China. Systematically the individuals from Korea and China are regarded as the same species as the Japanese form for they are apparently identical morphologically. This identity is further borne out by a general similarity of habits. They differ, however, in seasonal appearance, and in the fact that they are parasites of species of Popillia other than *P. japonica*. This seasonal difference is sufficiently great to make it best, for practical purposes in biological control, to consider the Korean and Chinese strains separately. This paper deals only with the Japanese form which has as its host *Popillia japonica*.

DIFFICULTIES IN IMPORTATION. Considerable difficulty has been experienced in the introduction of this Tiphia. In Japan host material, on which it was reared, was at times difficult to obtain, and grub collections generally suffered a 50 per cent mortality. The number of cocoons reared and shipped from Japan was 395 in 1920, 905 in 1921, and 2,050 in 1922, thus totaling 3,350. These cocoons were obtained from approximately 10,000 ovipositions, an efficiency of only 33 per cent.

At the receiving station further difficulties were encountered, as this species under rearing conditions in the insectary is most susceptible to fungous diseases. Losses of reared adults often resulted from their low vitality, and frequently the males so greatly preceded the females in emergence that their numbers were depleted by the time the females emerged.

In August, 1925, an experimental shipment of field-collected adults was sent from Japan, and of the 1,030 females shipped only 43 were received alive, and many of these were weakened by their long confinement in transit. A second shipment of adults was attempted in August, 1926,

[3]For the history and biology of this species see Clausen, C. P., King, J. L., and Termishi, Cho. The Parasites of *Popillia japonica* in Japan and Chosen (Korea) and their Introduction into the United States, U. S. D. A. Bull. 1429, pp. 33–39, 1927.

and of this material only 22 survived. These females were used in an experiment in artificial propagation, but none of their progeny reached the adult stage.

EARLY COLONIZATION AND ESTABLISHMENT. The first liberation of this species consisted of but a few individuals which survived the vicissitudes described. They have since proven to have been sturdy survivors and have repaid the effort and expense involved in their introduction. The first three successful colonies originated from liberations made by L. B. Smith, T. H. Frison, and H. A. Jaynes, who were conducting the domestic work at that time. Liberations were made as follows:

No. 1. The first colonizations were in 1921 and 1922 at Cinnaminson, New Jersey. A few adults of both sexes were released; the exact number is not recorded but we do know it did not exceed 50 individuals. In 1926 a colony was found to have become established; at that time numerous males were observed on the flowers of wild carrot and parasitized Popillia grubs were found in the same locality. Scouting indicated that the colony covered an area of approximately 4 acres. During August, 1927, adults of both sexes occurred in surprising numbers and the colony had spread to an area of one square mile.

No. 2. The second attempt at colonization was made near Cinnaminson, New Jersey, at a place called Siebke's pastures. The first releasement, in August, 1921, consisted of two mated females that had already deposited some eggs in captivity; and the second releasement, in August, 1923, consisted of six females. Recovery of two males was made at this locality in August, 1927.

No. 3. The third colonization was at Lippincott's pond between Moorestown and Cinnaminson, New Jersey. There 45 mated females were released in 1922 and 9 more the following year. At the time of recovery in August, 1927, the colony had spread over an area of approximately one-half square mile.

No. 4. The fourth locality of liberation is known as Lippincott's pasture near Moorestown, New Jersey. The releasement consisted of the 43 survivors of the initial shipment of adults received in September, 1925. To date (1929) no recovery from this liberation has been made.

In 1928 the three established colonies were scouted and sufficient recoveries were made on their outer limits to indicate a union. In 1929 this union was clearly evident, as males and females were found in abundance in the intervening areas, thus bringing the three colonies together, in an area of approximately 3.5 square miles. (Fig. 30).

SUBCOLONIZATION DURING 1927. As the colony in the Cinnaminson area had increased so astonishingly in numbers, it was concluded that

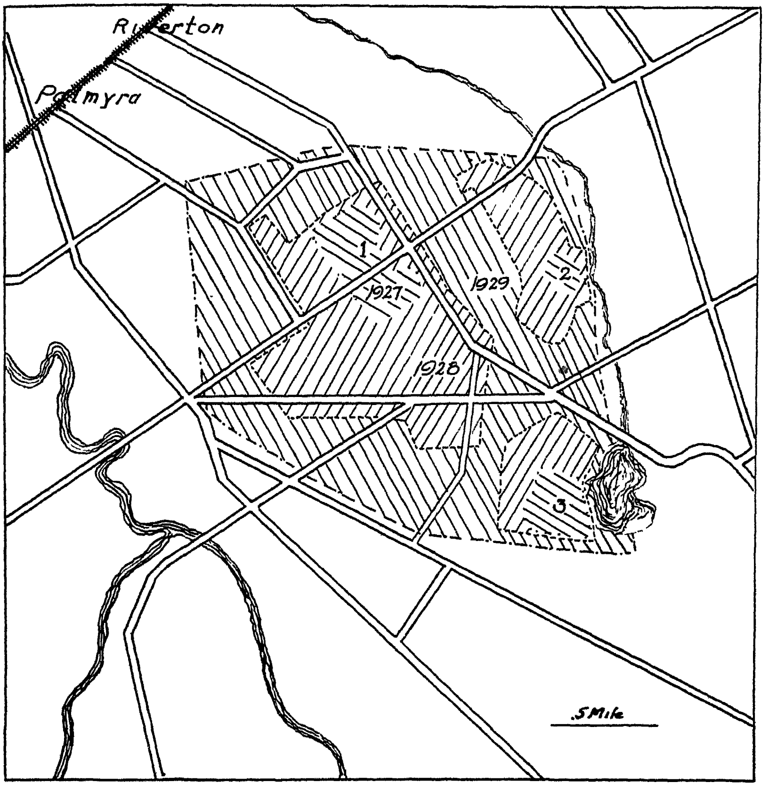


FIG. 30.—Map of the three original colonies showing their growth from 1927 to 1929 inclusive. No. 1—Center of Cinnaminson, liberations of 1921 and 1922. No. 2—Center of Siebke's pasture, liberations made 1921 to 1923. No. 3—Lippincott's pond, liberations 1922 and 1923.

by collecting and artificially diseminating the females a greater and more rapid dispersion could be obtained which would at the same time reduce competition within the colony center and facilitate the maximum increase of the parasite. It was believed that units of 100 females for each subcolony should give positive results when the success of the original releasements was considered. It has been observed in the field that female Tiphia wasps mate with the males almost immediately after their initial emergence from the soil in which their cocoons are located; thus practically all females collected from carrot and used in artificial dispersion have mated

Collections were made in the field during August, 1927, and 1,125 females were taken, 900 of these being released in lots of 100 each, in nine localities in Pennsylvania and New Jersey. One lot of 125 was shipped to Westbury, Long Island, for releasement in an area infested with *Phyllopertha orientalis* Waterh.,[4] and the remaining 100 were held in the insectary for oviposition on beetle grubs. From this lot 2,957 eggs were obtained. These, on their host grubs, were placed in the field, thus forming the nucleus of another colony, bringing the total number of colonies to eleven for 1927.

RECOVERY CHECK ON 1927 COLONIES. During August, 1928, the eleven releasements of 1927 were scouted for adults, resulting in eight recoveries including the locality where parasitized grubs had been placed in the field. Three localities, namely, Indian Mills and Berlin, New Jersey, which were questionable at the start, and Westbury, Long Island, New York, gave no recoveries. These failures may have been due to the fact that the localities in New Jersey were only sparsely infested with Popillia at the time the releasements were made, and the releasement at Westbury may have failed because of the change of host. On the other hand, recovery from any of these localities in the future is quite possible.

TABLE OF 1927 COLONIES AND RECOVERIES

Placed in Field	Locality	Number ♀ Tiphia	Recovery in 1928	Condition of Habitat
Aug. 19	Ellisburg, N. J.	100	Aug. recovery	Satisfactory
Aug. 20	Vincentown, N. J.	100	Aug. recovery	Satisfactory
Aug. 22	Parkville, N. J.	100	Aug. recovery	Satisfactory
Aug. 23	Berlin, N. J.	100	No recovery	Doubtful
Aug. 24	Columbus, N. J.	100	Aug. recovery	Satisfactory
Aug. 27–31	Indian Mills, N. J.	100	No recovery	Satisfactory
Aug. & Sept.	Birmingham, N. J.	2,957 parasitized grubs	Aug. recovery	Satisfactory
Aug. 19	Collegeville, Pa.	100	Aug. recovery	Satisfactory
Aug. 25	Emilie, Pa.	100	Aug. recovery	Satisfactory
Aug. 30	Bustleton, Pa.	100	Aug. recovery	Satisfactory
Aug. 22–26	Westbury, L. I., N. Y.	125	No recovery	Doubtful

The results of these recoveries clearly indicated that where units of 100 field-collected female Tiphia were liberated under favorable conditions establishment was almost certain. It was found that a satisfactory colonization point may be one in which Popillia breeding ground

[4]During the summer of 1926 a series of tests were made to determine whether *T. popilliavora* would accept *Phyllopertha orientalis* as a host. The results obtained in the insectary were highly favorable, and in 1927 the above shipment was made to the vicinity of Westbury as a practical test; here 110 females were liberated and 266 parasitized Anomala grubs were "planted" out. No recoveries have so far been made from this releasement.

is plentiful and moderately drained and in which host larvae occur at the rate of at least 1 per square foot. Also, wild carrot (*Daucus carota*), the favorite food plant of *T. popilliavora*, must be present in fair abundance.

SUBCOLONIZATION DURING 1928. During August, 1928, a second collection of Tiphia was made at Cinnaminson and 4,330 females were procured for further subcolonization. This material was released in lots of 100 or more females in thirty localities within the heavily Popillia-infested areas of Pennsylvania and New Jersey (Fig. 31). On Long Island, New York, a releasement of 200 adults was made at Flushing, which is in an outlying infestation of Popillia.

In the areas infested with *Phyllopertha orientalis* two liberations were made, one at Jericho, Long Island, of 200 adults and 118 parasitized Anomala larvae, and another at New Haven, Connecticut, of 200 females.

SUBCOLONIZATION DURING 1929. In the Cinnaminson area in 1929 the first emergence of *T. popilliavora* was noted August 5, at which time males were abundant. Only three females were seen on the first day of emergence. An attempt to collect the wasps in numbers was made on August 9, at which time six collectors were able to obtain only 100 females. After a delay of three days a second attempt was made, resulting in 200 females, and from this time on collecting was continuous, except Sundays, until August 28.

As it was desired to place as many colonies in the field as possible, five extra men were employed. The work was divided into two groups, collecting and colonization.

Collecting: During the first nine days of the month the extra men prepared equipment such as collecting tubes with plaster of Paris bottoms, and receiving tins for transportation to new fields. A temporary field cage, in which to transfer material from tubes to containers, was constructed in the center of the collecting area. As soon as the Tiphia began to appear the collectors were taught to recognize them. This accomplished, a hasty survey was started to determine the extent of the area. The collectors were required to bring in all Tiphia species, males and females, for further verification, and from data so obtained the extent of the colony was estimated.

Within the area determined for 1929, (Fig. 30) there was a very noticeable increase in numbers over the previous year, and it was found that profitable collecting could be conducted almost anywhere within the area.

The number of men collecting varied from day to day, but the average was seven, over a period of 17 days. During this time the daily aver-

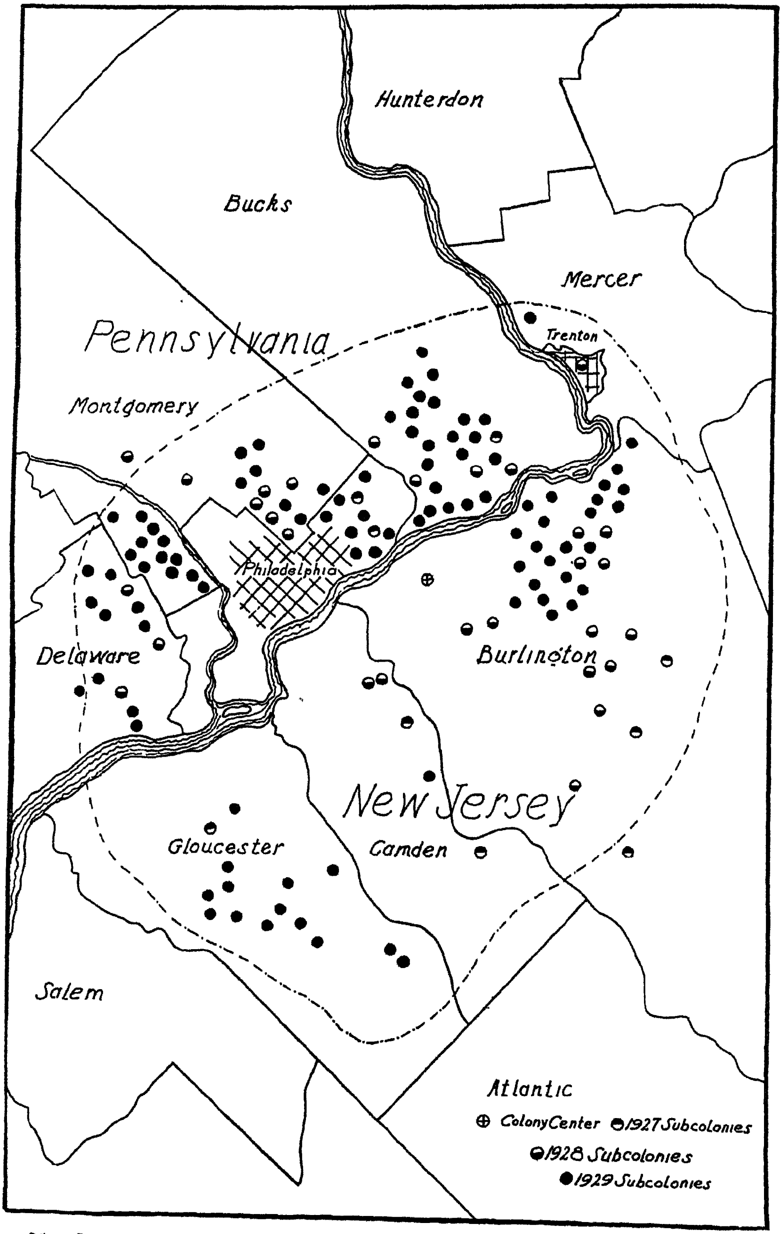


FIG. 31.—Map showing location of colony center and distribution of subcolonies of 1927 to 1929 inclusive. Broken line encloses area of heavy infestation of *Popillia*.

age collection was 594, an average of 84.9 per man. The total collection amounted to 10,100 females.

Subcolony Distribution: Mr. R. W. Burrell, Junior Entomologist in the division, with the assistance of two men took charge of the placing of colonies. The area for colonization was divided into four districts, three in Pennsylvania and one in New Jersey. Each day's collection of Tiphia was distributed the following day in one of these sectors. Extreme care was used in selecting the exact point of liberation, especially to see that beetle larvae were present over extensive grasslands and that wild carrot was in close proximity to these areas. The 10,100 Tiphia were thus distributed in 100 local colonies of 100 each with only one outlying colony of 100, which was placed in Harrisburg, Pa., (Fig. 31).

The exact location of each colony was carefully noted on topographic maps marked with the location and necessary data.

The following list gives the subcolonies placed in counties and townships of New Jersey and Pennsylvania in 1928 and 1929.

Recovery 1929: No recovery campaign was planned for 1929 because it was deemed that rapid subcolonization was more important, this being justified because of the abundance of material present and the success of the 1927 subcolonies. However, while releasements were being conducted three of the 1928 colonies were scouted and recoveries were made. It is planned to conduct during August, 1930, a complete check for all points of liberation of this species.

NEW JERSEY

County	Townships	1928 Colonies	1929 Colonies
Burlington	Beverly		4
Burlington	Bordentown		3
Burlington	Burlington	1	
Burlington	Chester	2	
Burlington	Delran		1
Burlington	Easthampton	1	
Burlington	Florence	1	2
Burlington	Lumberton	1	
Burlington	Mansfield		5
Burlington	Medford	1	
Burlington	Northampton	1	
Burlington	Springfield	2	
Burlington	Westhampton	2	4
Burlington	Willingboro		5
Camden	Pensauken	2	
Camden	Delaware		1
Gloucester	Deptford		2
Gloucester	Mantua		4
Gloucester	Monroe		2
Gloucester	Washington		1
Gloucester	Glassboro		1
Gloucester	Harrison		4
Mercer	Trenton	1	
Mercer	Ewing		1

PENNSYLVANIA

County	Townships	1928 Colonies	1929 Colonies
Bucks	Bensalem	2	8
Bucks	Bristol	2	3
Bucks	Middletown		7
Bucks	Newtown		1
Bucks	Northampton		1
Bucks	Southampton		2
Delaware	Haverford	1	6
Delaware	Radnor		1
Delaware	Ridley	1	2
Delaware	Springfield		2
Delaware	Upper Darby	2	
Montgomery	Abington	3	3
Montgomery	Cheltenham	2	2
Montgomery	Lower Merion		11
Montgomery	Moreland		2
Montgomery	Springfield	1	
Montgomery	Upper Merion		1
Montgomery	Upper Dublin	1	
Philadelphia	Philadelphia		8
Total subcolonies in heavily infested area		30	100
Outlying subcolonies			
Pennsylvania	Harrisburg		1
New York	Long Island	2	
Connecticut	New Haven	1	
Total of all subcolonies 1928 and 1929		33	101

CONCLUSIONS. *T. popilliavora* is a specific parasite of *Popillia japonica* in its native land, and in this country this specific tendency is preserved.[5] Comparisons show that the time of emergence and the period of adult activity and larval development are the same here as in Japan. This indicates that the soil temperatures throughout the year are favorable for its normal development. This Tiphia frequents the flowers of wild carrot (*Daucus carota*) almost to the exclusion of other plants. In the present area infested with Popillia, wild carrot is very abundant and widely distributed. It is believed, because this Tiphia is specific in its habits and is so perfectly adjusted to its new environment with the selection of an abundant food plant, that it will prove to be one of the most important parasites acting in the biological control of the Japanese beetle.

[5]The acceptance of *Phyllopertha orientalis* by this Tiphia has only been under artificial conditions. If finally established within an area inhabited by both imported beetles preference would doubtless be shown for the true host.

AN ELECTRICAL TRAP FOR KILLING JAPANESE BEETLES[1]

By FLOYD E. MEHRHOF, *Agent* and E. R. VAN LEEUWEN, *Associate Entomologist, Bureau of Entomology United States Department of Agriculture*

ABSTRACT

This paper reviews the results of a two year effort to construct and develop an electrical trap for use against the Japanese Beetle and the results of field experiments.

During the past few years traps have come into general use for capturing large numbers of Japanese beetles[2] (*Popillia Japonica* Newm.). In a paper by Richmond and Metzger[3] it was pointed out that a large number of beetles that are attracted to the traps are not captured, and that others, which have apparently become greatly excited by the aroma of the geraniol-eugenol bait, strike the funnel of the trap, lose their equilibrium, and are precipitated in more or less by accident. Because of these facts, investigations were conducted by the writers for the purpose of improving the present type of trap and of devising a trap into which the beetles would fly directly. The use of electricity for this purpose was suggested by Mr. L. B. Smith, in charge of the Japanese Beetle Laboratory, and the results are reported in this paper.

PRELIMINARY EXPERIMENTS. During the summer of 1927 experiments were conducted in which Japanese beetles were killed with alternating electric currents of different frequencies and voltages. The most satisfactory results were obtained with a frequency of 60 cycles and from 10,000 to 12,000 volts. A simple trap was then constructed On a wooden frame bare copper wires were stretched parallel to one another at equal intervals. Alternate wires were connected together so that there was a difference in potential of 10,000 to 12,000 volts between any two adjacent wires. The interval between the wires was sufficient to prevent sparking, except when a beetle would fly between two wires, in which case the resistance was decreased to such a point that a spark would jump from one wire to the other through the beetle. The presence of the wires appeared to have no influence upon the flight of the beetles.

THE ELECTRIC TRAP. During the summer of 1928 an electric trap (Plate 9 and figs. 32, 33) was tested in a peach orchard and in an open

[1]Contribution No. 63 of the Japanese Beetle Laboratory, Moorestown, New Jersey.

[2]Metzger, F. W. Information concerning Japanese beetle traps. New Jersey Dept. Agr. Circular 146, p. 8, illus. 1928.

[3]Richmond, E. A., and F. W. Metzger. A trap for the Japanese Beetle. Jour. Econ. Ent. 22:299–317, illustr. 1929.

field near the Japanese Beetle Laboratory. This trap was constructed in the form of a hollow cube, with the parallel conductor wires, spaced 5/8 inch apart on all four sides and on top. A geraniol bait was suspended in the center. The dimensions of the trap, 3 feet on each edge, were decided upon because it had been noted that beetles attracted by geraniol fly around with greatest activity within a radius of about two feet from the attrahent, and in a trap of this size the beetles would be very likely to fly between the parallel wires. A unit type of construction makes it possible to build the trap in any desired size.

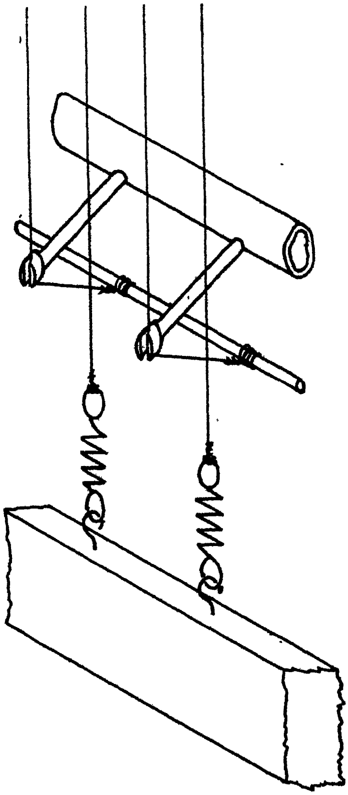


FIG. 32.—Detail showing space insulation and method of maintaining tension and proper intervals of conductor wires. This construction prevented the accumulation of dead beetles around the conductor wires, and eliminated short circuits due to this cause.

The wooden frame that was used in this trap was satisfactory as an insulator only when it was dry. During the course of the tests it became damp after prolonged rains, in spite of the fact that it was coated with paraffin, and several of the joints had to be modified when they failed electrically. This defect could be remedied by using a metal frame and porcelain or other suitable insulators.

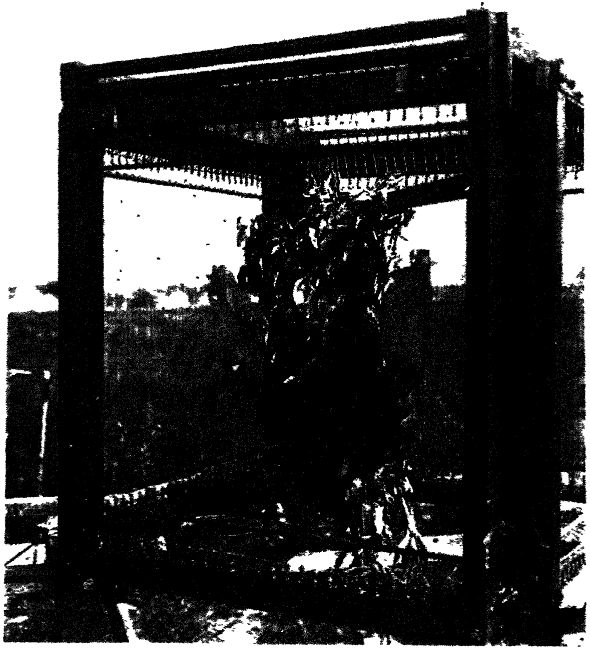
The electrical trap is as safe to operate as any of our electrical household appliances. During the period it was tested no birds were killed.

FIELD TESTS OF THE ELECTRIC TRAP. The trap was tested first on supports 4½ feet high in a peach orchard, from July 17 to 25. On July 26 it was raised to 9 feet, where it was left until August 1. From August 1 to 13 the trap was tested at an elevation of 9 feet in an open field 100 yards from the peach orchard, and a count that was made under favorable conditions showed 422 beetles caught in five minutes.[4] As

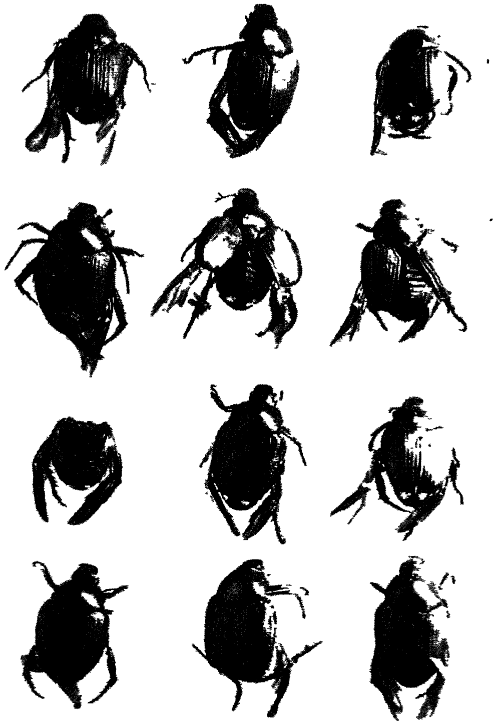
[4]Mr. F. W. Metzger estimates that, under most favorable conditions, beetles were killed at the rate of 150 per minute.

Plate 9

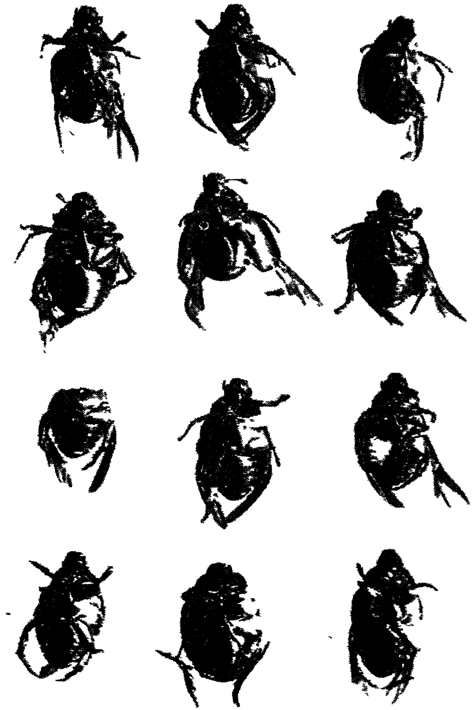
The electric trap. The trap is resting on supports 4½ feet high. A 250-watt step-up transformer, a resistance coil, and a condenser are in the large box under the trap. A few dead beetles may be seen below the trap. The danger sign wa placed on the trap to prevent outsiders from molesting it



Near view of electric trap, showing construction.



Electrocuted Japanese beetles; dorsal aspect.



Electrocuted Japanese beetles; ventral aspect.

beetles were not very active or abundant at Moorestown during these tests, the number of individuals killed was lower than it would be where conditions were more favorable for the beetles.

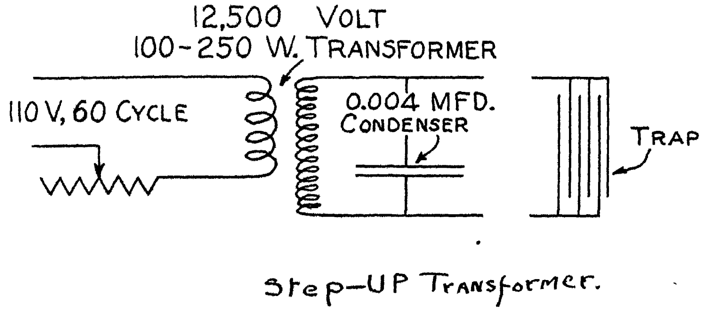


FIG. 33.—Diagram showing wiring of the electric trap.

TABLE 1. NUMBER OF BEETLES KILLED BY THE ELECTRIC TRAP

Date	Height of Trap Above Ground	Hours in Operation	Number of Beetles Killed	Beetles Killed per Hour
July 17–25.............	4½ feet	26.25	15,518	592
July 26 to August 1.....	9 feet	27.50	25,726	935
August 1 to 13.........	9 feet	31.00	26,564	857

Some of the beetles showed signs of life when they fell from the trap after receiving a discharge. Several lots were therefore collected and placed in cages provided with food, where they were observed for 48 hours. The results are shown in Table 2.

TABLE 2. PERCENTAGE OF MORTALITY IN BEETLES COLLECTED AROUND THE ELECTRIC TRAP

Date	Number of Beetles Collected	Number of Beetles Alive After 48 Hours	Percentage of Beetles Alive After 48 Hours
August 3.......	9,105	78	0.86
August 6.......	3,542	97	2.73
August 14......	5,417	103	1.90

It should be remarked that the beetles were collected from a sheet of canvas spread on the ground beneath the trap, and that some beetles, which were feeding on nearby weeds, attracted by the dead beetles, flew to the canvas, and were collected along with the others. This would account for most, if not all, of the survivals at the end of the 48 hour period, especially in view of the fact that there were no survivors among 150 beetles which were caught as they fell from the trap, and observed at the end of 24 hours. Mr. E. A. Richmond, who examined beetles that had been electrocuted, reported that "of 32 beetles, 4 alive when collected, only 13 showed signs of external injury; the remaining 19

showed no external injury. Twenty-five of these beetles showed either damaged wings or abnormal wing position." The abnormal wing position referred to is very characteristic of the effects of the electrical discharge on beetles. In a large number of cases the wing covers were severed from the body. Some of these effects are shown in Plate 10.

The most effective bait for use in the electric trap was geraniol emulsion sprayed on peach branches which were suspended in the center of the trap. By this method, beetles were at times attracted from a distance of one-quarter of a mile. The best height for the trap was found to be about 9 feet.

The voltage should be high enough to kill the beetles, and should be only slightly below the point at which the field will break down, as this makes the trap very sensitive. There should be sufficient impedance to prevent more than one discharge through the beetle as it flies between the wires.

The trap consumed between 0.13 and 0.18 K. W. per hour, depending upon the number of beetles that were killed. This is about equivalent to the power consumption of two 75-watt incandescent bulbs, and would cost approximately 1.5 cents per hour.

Conclusions. The range of effectiveness of the electric trap is greater than that of traps of other types because a greater surface of the attrahent that is used as bait can be exposed without any confinement.

Practically all of the beetles that are attracted to the trap are killed.

The electric trap, because of its great range of effectiveness and its high killing efficiency, provides the best means for comparing the value of different attrahents.

This trap with slight modification in construction should be of especial value for use on large estates, golf courses, and parks, where its bulk, its greater initial cost, and the extra labor required to set it up would not be serious disadvantages.

THE VALUE OF SMUDGES AS REPELLENTS FOR THE JAPANESE BEETLE[1]

By F. W. Metzger, *Assistant Entomologist*, and D. H. Grant,[2] *Agent*,
Bureau of Entomology, United States Department of Agriculture

Abstract

A description is given of the preparation of one type of smudge base and its impregnation with various volatile substances. The field tests with these smudge candles are discussed and conclusions drawn as to their practical value as repellents.

[1]Contribution No. 64 of the Japanese Beetle Laboratory, Moorestown, New Jersey.
[2]Resigned October 1, 1929.

The use of smudges against the Japanese beetle was undertaken as part of the investigations on repellents conducted at the Japanese Beetle Laboratory. Although it was realized that smudges, even if effective as repellents under some conditions, could not be employed under all conditions, it did appear that it might be possible to use them to advantage in the control of the beetle on early peaches. A few preliminary tests were conducted during the summer of 1928, but the greater portion of the work was done in July, 1929.

Tests Conducted in 1928. In the first tests, cotton waste was soaked with fuel oil and burned in various types of containers such as 12 and 16 quart pails and shallow stew pans. It burned too rapidly in all of these tests, so perforated lids were placed on the containers to retard combustion. It was found that when the supply of air was reduced to a certain point the waste would smolder and give off a dense smoke for a few minutes, but would shortly become extinguished. When the draft was increased so that the waste flamed there was very little smoke, and no appreciable repellent effect on the beetle was noted. The addition of pine-tar oil to the saturated waste increased the flame, but the repellence was only slightly greater than that of the burning waste alone.

The tests conducted in 1928 showed that it was necessary to develop a base which would burn slowly without attention, and, at the same time, give off considerable smoke.

Smudge Candles Developed in 1929. The junior author, after considerable investigation, discovered that wood flour and potassium nitrate, when mixed together in the proper proportions, formed a smudge base which possessed all the qualifications mentioned above. This combination burned slowly and evenly, and gave off a considerable volume of light-colored smoke. It had the further advantages of being comparatively cheap and easy to prepare. It was made as follows: One kilogram of potassium nitrate was dissolved in 3,000 cc. of warm water. To this solution was added 40 cc. of a one per cent aqueous solution of methylene blue to serve as an indicator of the thoroughness of the subsequent mixing. This solution, measuring 3,250 cc., was mixed with 3,250 grams of wood flour, the mixing being continued until the material showed a uniform greenish-blue color. The damp mass was then spread out in shallow pans until it was air-dry. To each kilogram of the dry mixture was then added 1,220 grams of wood flour alone, making the proportion of potassium nitrate in the finished base about 10.7 per cent by weight. Mixing at this stage was performed in

a mechanical mixer as was the subsequent combination of the smudge base and the materials being tested.

It was found that 1 kilogram of the smudge base, thus prepared, could be mixed with 1 liter of liquid or 1 kilogram of solid repellent compound without unduly retarding its burning rate, and these proportions were used in all cases. The final mixture was placed in cylinders made of 16-mesh wire screening, 31 inches long and 2¼ inches in diameter. These candles burned from five to eight hours, depending on the material that was incorporated in the base. Plate 11 shows a candle in operation.

Field Tests. The smudges were used on peach trees of the Early Rose variety, and tests of each material were conducted on lightly and heavily infested trees. The fruit was almost ripe when the tests were begun. One candle to a tree was used at first, but proved to be ineffective, and the number was increased to two, and later to three. The candles were located so that all parts of the tree would receive some of the vapor. They were ignited at 10 A.M., and allowed to burn until 4:30 P.M. The wind was very light during the entire period that the candles were in use, but even a light current of air was sufficient to divert the fumes so that they were carried away from the tree instead of floating slowly up through it.

Results. Pine-tar oil, commercial, Dippel's oil, (bone oil), commercial, and a commercial mixture of chloronaphthalenes were the most satisfactory of the six substances tested for repellence by this method. The candles which contained these materials burned at an even rate, and gave off thick clouds of smoke which were heavily charged with repellent vapors. The fumes from neutral hydrocarbon oil (from coal tar) cresylic acid, 95 per cent dark, and naphthalene were much less repellent than those from the three substances mentioned above. Several candles of the smudge base alone proved to be only slightly repellent.

Repeated observations showed that contact for one or two seconde with the repellent vapor disturbed beetles, but that it did not caus- them to leave fruit or foliage. When the insects were constantly subs jected to the fumes for a period of from five to ten seconds, however, they would actually fly away. Most of them would rise a few feet in the air, but instead of leaving the vicinity they would merely alight on the same tree at points not reached by the fumes at that particular moment.

The repellence of pine-tar oil, Dippel's oil, and a commercial mixture of chloronaphthalenes was so marked that it appeared that a heavily

Smudge candle.

infested peach tree might be cleared of beetles in a few hours, provided that all parts of the tree could be enveloped with the fumes at the same time. It was impossible, however, to obtain such a condition, even when three candles were placed in different parts of the same tree. A larger number of candles per tree was not employed as such a course was not considered practicable.

Although three of the six materials that were tested in smudges proved to be strongly repellent to the beetle, their use does not appear to give satisfactory control of the beetle on early peaches.

SUMMARY. Wood flour and potassium nitrate, when mixed together in the proper proportions, form a satisfactory base for smudges.

The fumes from pine-tar oil, Dippel's oil, and a commercial mixture of chloronaphthalenes, when given off from burning smudge candles, are definitely repellent to the Japanese beetle.

Air currents in the field prevented the materials tested in smudges from giving satisfactory control of beetles on early peach trees.

SOME OBSERVATIONS UPON THE BIOLOGY AND CONTROL OF *ASERICA CASTANEA* ARROW[1]

By HAROLD C. HALLOCK, *Associate Entomologist, Division of Deciduous-Fruit Insects, United States Bureau of Entomology*

ABSTRACT

This paper deals with the life history of *Aserica castanea* and methods of control. The lawn turf should be treated with acid lead arsenate in order to secure grub proof turf. A spray of lead arsenate on the food plants of the adult beetle is proving effective. The introduction of parasites to aid in the control of the beetle has been started.

The information given in this paper is based upon work done by the United States Department of Agriculture during the seasons of 1927, 1928, and 1929.

Adults of *Aserica castanea*, the oriental garden beetle, were first collected in New Jersey in 1921. Injury to foliage in flower gardens was reported in Mount Vernon, New York, in 1926. The insect was then determined as *Aserica castanea* Arrow. In 1927 research work was started at Westbury, Long Island, by the United States Department of Agriculture, and in northern New Jersey by the New Jersey Department of Agriculture. Two years later, in the spring of 1929, *Aserica castanea* was included in the Japanese and Asiatic Beetle Quarantine.

[1]Contribution No. 66 Japanese Beetle Laboratory, Moorestown, New Jersey.

The known distribution in America of the oriental garden beetle includes parts of the following states: Connecticut, Delaware,[2] New York, New Jersey, Maryland, Pennsylvania, and the District of Columbia. The beetle has occurred in sufficient numbers to cause economic damage in Nassau, Queens, and Westchester Counties in New York State, in northeastern New Jersey, in and around the cities of Philadelphia and Harrisburg, Pennsylvania, and in Washington, D. C.

Life History. The adult beetles generally appear in the field about the first of July. The first adult in 1929 was found on June 25. Living adults have been found in the field concealed at the base of their food plant as late in the fall as October 16 and were very active when dug out of the ground. They are most abundant during a period of one month from July 15 to August 15 (Fig. 34.). They fly and feed only at night,

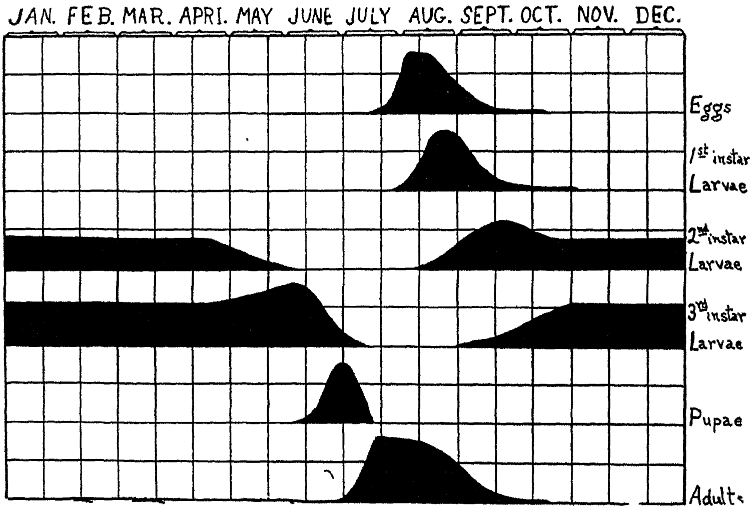


Fig. 34.—*Aserica castanea:* Approximate seasonal occurrance of the stages in the field.

and generally conceal themselves in the moist ground at the base of their food plants or in grass land during the day. On cool nights, when the temperature is below 70°F., some of the beetles come out of the ground and feed a little on grass and other low-growing herbage, but they are not active. On warm nights, however, they fly like swarms of bees.

[2]The records in Delaware and Maryland were secured from Mr. C. H. Hadley and the exact locality will be given, Hadley C. H., Present distribution of the Japanese beetle (*Popilla japonica* Newm.) and the Asiatic beetles (*Aserica castanea, Anomala orientalis*) in the United States. Jr. Econ. Ent., 1930.

They are attracted to lights, and gather on electric light poles. This fact is made use of in scouting. During the summer of 1928, in one electric light trap 188,250 beetles were caught, and 21,000 were taken in one night in the same trap. This electric light trap was used at the same location in the summer of 1929 but only 107,690 beetles were caught. In 1929 there were about four periods in the summer when the beetles flew abundantly and these were nights when it remained warm up to midnight (Fig. 35).

The adults mate readily during the period of activity at night, and mating and egg laying are continued at irregular intervals until fall. Eggs are laid by preference in uncultivated places such as lawns or

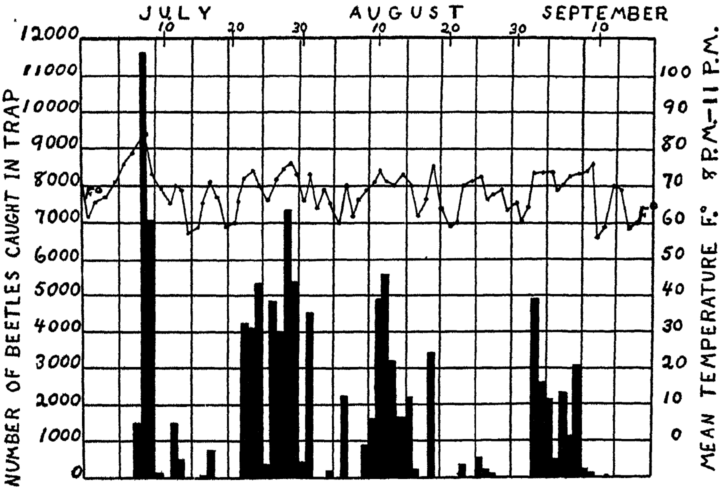


FIG. 35.—*Aserica castanea:* Graph showing relation between temperature and number of beetles caught by one electric light trap in 1929.

grass fields and in moist but not swampy ground. Although 178 eggs have been laid by one beetle in a cage, the average number per beetle is about 60. They are laid in clusters varying from one to nineteen eggs each, loosely held together with a gelatinous substance, and are found in the ground at depths of from ½ inch to 4 inches, although most of them are near the surface.

The young grubs, which hatch about 10 days after the eggs are laid, feed actively on grass roots and decaying vegetable material in the upper 1 to 4 inches of soil. Three-fourths (Fig. 34) of the grubs molt twice during the first season, so only about one-fourth are still in the second instar when they begin to migrate to winter quarters about October 15.

They winter from 9 to 15 inches deep, but it is possible for them to survive closer to the surface even when the ground is frozen hard. They return to the top four inches of soil about the middle of April, and feed extensively on grass roots until about the middle of June. When the third-instar grubs complete their growth, each grub prepares an earthen cell 1½ to 4 inches below the surface in which it transforms to a pupa, and, about 10 days later, to an adult beetle. Before pupation the grub passes about five days in a dormant prepupal state. The pupa, unlike that of the Japanese beetle or Asiatic beetle, pushes the cast larval skin back beyond the tip of the abdomen, and lies naked in its earthen cell.

FOOD-HABITS OF ADULT BEETLE. Observations have been made at night with a flash-light which show that this insect feeds upon more than 50 different species of plants. Although Aster, Chrysanthemum, Dahlia, and Phlox are their favored food plants, they will feed upon plants which vary considerably in type. They have even been observed feeding upon evergreen seedlings. The following partial list of food plants gives only those plants which have been found conspicuously defoliated. The species most vigorously attacked are marked with an asterisk.

PARTIAL LIST OF FOOD PLANTS OF ADULT *Aserica castanea*

Aster spp.*
Bean, *Phaseolus* sp.
Blueberry, *Vaccinium* spp.
Burdock, *Arctium* spp.
Butterfly Bush, *Buddleia variabilis**
Carrot, *Daucus carota*
Cherry, *Prunus* spp.*
Chrysanthemum spp.*
Currant, *Ribes* spp.*
Dahlia spp.*
Devil's Walkingstick, *Aralia spinosa**
*Gaillardia grandiflora**
Geranium, *Pelargonium domesticum*
Indian bean, *Catalpa* spp.
Japanese barberry, *Berberis thunbergi*
Locust, *Robinia pseudoacacia*
Peach, *Amygdalus persica*
Phlox spp.*
Plantain, *Plantago* spp.
Plum, *Prunus* spp.
Radish, *Raphanus sativus*
Rhubarb, *Rheum rhaponticum**
Rose, *Rosa* spp.*
Smartweed, *Polygonum pennsylvanicum*
Strawberry, *Fragaria* spp.
Strawflower, *Helichrysum bracteatum**
Sunflower, *Helianthus annuus**
Sweet mock orange, *Philadelphus coronarius**
Tree-of-heaven, *Ailanthus glandulosa**
Willow, *Salix* spp.
Viburnum sp.
Zinnia sp.

GRUB CONTROL.[3] The application of lead arsenate to lawns in New York State has shown that the same treatment that is used for Japanese beetle will give protection to the lawn. As the *Aserica* grubs tend to feed deeper in the ground than those of *Anomala* or *Popillia*, it appears

[3]Leach, B. R. Further experiments in the control of Japanese beetle grubs. Bul. U. S. Golf Assoc., Green Section, 8:28–33, illustr. 1928.

from the observations that have been made that it may be somewhat harder to secure a grub-proof turf when dealing with *Aserica.*

Treatment of New Lawns with Lead Aresnate. When the soil is being prepared previous to sowing the grass seed, three and one-third pounds of acid lead arsenate should be uniformly broadcast on the surface of each 100 square feet of ground to be treated. In order to aid in obtaining a uniform distribution of the poison it may be mixed with two or three times its bulk of moist but not wet soil. Following the application, the ground should be thoroughly disked or cultivated in order to work the lead arsenate in to a depth of between three and four inches. The lawn may then be seeded and treated in the usual manner. This treatment will be effective for a period of four or five years.

Treatment of Old Lawns with Lead Arsenate. In cases where the turf has not been killed by the larvae, the arsenical may be applied as a top dressing at the rate of one-half pound to each 100 square feet of lawn. Measure the area to be treated and determine the quantity of lead arsenate required. The arsenical should be thoroughly mixed with 15 times its weight of good top soil. This mixture should be applied broadcast at the rate of 7½ pounds to each 100 square feet of surface. Repeat once each year for three years.

Mowing, watering, and other customary operations may be continued as usual. The treatments may be applied any time between April 1 and October 30, providing the ground is not frozen.

SPRAY FOR ADULTS. Plants which are severely attacked by adults should be sprayed with three pounds of lead arsenate and two pounds of wheat flour to 50 gallons of water.

During July and August 1929, spray experiments with the adult beetle were conducted under field conditions. Chrysanthemums and zinnias were sprayed with three pounds of lead arsenate and two pounds of wheat flour to 50 gallons of water. Daily counts of the living and dead beetles concealed in the ground at the base of these plants were made. The percentage dead increased from 0 per cent at 24 hours to 54 per cent at the end of 120 hours, and even 33 per cent of those collected at the end of 216 hours were dead. The living beetles, in each collection, were placed in a cage with food. An equal number of beetles from an unsprayed locality were placed in a check cage. These cages were kept at the insectary for 168 hours and counts of the dead beetles made every day. A summary of the results are given in the following table.

TABLE 1. DEATH RATE AMONG *Aserica castanea* BEETLES COLLECTED AT BASE OF SPRAYED PLANTS

No. Hours Collected After Spraying	No. Beetles From Sprayed Plants	No. Beetles in Check Cage	Percentage Which Died During 168 Hours After Collection From Sprayed Plants *Per cent*	From Unsprayed Plants (Check) *Per cent*
24	569	569	55	21
48	474	474	64	22
72	158	158	64	17
120	223	223	97	10
168	153	153	92	18
192	259	259	52	17
216	277	277	69	19

NATURAL CONTROL. It is felt that, in the long run, control of the oriental garden beetle by parasitic insects will be most satisfactory. An oriental species of *Tiphia* which is normally parasitic on *Serica*, has been found to attack *Aserica castanea* readily under laboratory conditions. At the present time 6,000 cocoons of this species are being held at the Moorestown laboratory under controlled temperature and humidity conditions. These will be reared, and the adults shipped to Westbury, Long Island for liberation at a point of heavy infestation.

Scientific Notes

***Aphelinus mali* in Brazil.** In a recent letter received from Dr. A. da Costa Lima, of the Oswaldo Cruz Institute at Rio de Janeiro, occur the two paragraphs that follow:

"I have also received your paper on *Aphelinus*. When I worked in the Instituto Biologico, we, of the 'Serviço de Vigilancia Sanitaria Vegetal', through the kindness of our colleague Sundberg, succeeded in establishing permanently and successfully that parasite in Brazil.

"The initial work of acclimation was done by our Inspector in Rio Grande do Sul—Dr. Eugenio Bruck, who further sent several colonies to Minas Geraes State and to the Instituto Agronomico of Campinas (São Paulo)."

L. O. HOWARD.

A Note on the Food Habits of *Chyliza erudita* Mel. (Diptera). On September 18, 1925, the writer collected what appeared to be dipterous puparia about wounds on white pine (*Pinus strobus*) in the forest near Lake Francis, which is located just west of the Adirondack Mountains, near Number Four, New York. Two adult specimens were reared and these were identified by Dr. O. A. Johannsen as *Chyliza erudita* Mel. The puparia from which these specimens were reared were found in the pitch which exuded from the edge of wounds on the lower part of the trunk of white pine. This seems to indicate that *Chyliza erudita* feeds upon pitch in the larval stage.

LAWRENCE PAUL WEHRLE

A New Pupal Parasite of the Sugar Cane Moth Borer, *Diatraea saccharalis* Fabr. While making a survey of the sugar cane moth borer in Southeast Texas, in 1928, several pupal cases of the borer were taken from early maturing corn near Liberty,

Liberty County, Texas, and placed in jars. Moths emerged from most of the pupal cases, however, one pupa was parasitized and several hundred parasites emerged on June 29, 1928. These were sent to the U. S. N. Museum and were identified by Mr. A. B. Gahan as *Syntomosphyrum esurus* Riley. He stated that the only previous record of a pupal parasite of *Diatraea saccharalis* known to him is that of *Heptasmicra curvilineata* Cameron by Cleare in the Jour. Bd. Agric. of Brit. Guiana, Vol. 15, 1922, page 182.

J. N. RONEY, *Division of Entomology, Texas Agricultural Experiment Station*

A Parasite of the Sunflower Weevil. During some preliminary studies on the life history of the Sunflower Weevil, *Desmoris fulvus* Lec, a Chalcid parasite was reared from larval material. Sunflower seeds infested with the weevil were obtained from fields in Moultrie county, Ill., Nov. 24, 1928, and kept in common storage until about April 8, 1929. These were then brought into the laboratory. While examining the seeds April 13, 1929, during which examination each seed was broken open, an adult of the parasite was taken from one of the seeds showing weevil infestation and remnants of the weevil larva. The parasite is *Callimome albitarse* Huber. Identification was made by Dr. Gahan at Washington, D. C.

The statement was made by T. D. A. Cockerel, Can. Ent. 47, 281, 1915 that adults of *Callimome* sp. were present at the heads of sunflowers in Boulder, Colo., but I believe that this is the first definite observation of the parasitism.

J. H. BIGGER, *Illinois Natural History Survey*

Nitidulid Beetle Reared from Orange. The small nitidulid beetle, *Epuraea luteola* (Er.) [*Haptoncus luteolus* (Er.)], was recently reared by the writer from an orange taken in the markets of San Francisco, California and presented by Mr. W. Vincent, Food and Drug and Insecticide Administration, on September 2, 1929. The larvae at that time occurred in a decayed spot about an inch in diameter, which looked very much like an area inhabited by maggots of the fruit fly, on the otherwise sound orange. In fact the collector was very much afraid that he had an important find. An examination of the larvae soon dispelled all apprehensions as they were easily determined as the immature forms of a nitidulid beetle. The fruit was placed in a jar and adults subsequently reared, which were determined by E. C. Van Dyke as *Epuraea luteola* (Er.). This beetle is about 1.5 mm. long, rather wide, uniformly pale yellowish-brown, and with the posterior tip of the abdomen projecting slightly beyond the elytra.

Van Dyke has specimens reared from decayed fruits from Porterville, California (1928) and from Whittier, California (1929). He informed me that H. C. Fall had collected it in southern California several years ago. C. Leng reports it, under the name *Haptoncus luteolus* (Er.), and the synonym *H. texanus* Cr., from Central America, Texas and Florida.

E. O. ESSIG, *University of California, Berkeley, Calif.*

Notes on *Trichogramma minutum* Riley as a Parasite of *Acrobasis caryae* Grote. A few *Trichogramma* parasites were liberated on one pecan tree during periods in August and September 1929 when eggs of *Acrobasis caryae* were present. For the determination of the extent of parasitism, a total of 511 eggs of *Acrobasis caryae* were collected. The number of eggs found to be parasitized was 126, or 24.6 per cent

of the number that were examined. Adults of *Trichogramma minutum* were reared from the eggs of *Acrobasis caryae* and some of those parasites were successful later in attacking the eggs of the same species from which they were bred.

H. S. Adair and C. C. Pinkney were successful in securing parasitization of the eggs of *Acrobasis caryae* by *Trichogramma minutum* under laboratory conditions during the summer of 1928. However, they did not recover any adult *Trichogramma* from eggs of *Acrobasis caryae* collected on a pecan tree, where a previous liberation of that parasite had been made.

On September 18, 1929, 75 eggs deposited by *Acrobasis caryae* were placed in a petri dish with a few *Trichogramma* parasites which were bred from eggs of that species. Examination made five days later showed that 71 of those eggs were parasitized.

C. B. Nickels and C. C. Pinkney, *U. S. Pecan Insect Laboratory, Brownwood, Texas*

Hibernation of the Convergent Lady Beetle, *Hippodamia convergens* Guer., on a Mountain Peak in New Mexico. For several years the writer has observed the hibernation of the convergent lady beetle on Mosca Peak in the Manzano Mountain Range, 30 miles southeast of Albuquerque, New Mexico. Mosca Peak resembles a pyramid in form and its precipitous escarpment rises to an elevation of 9,462 feet above sea level and more than 3,000 feet above the Estancia Valley. The summit is 10 or 12 feet in diameter and is covered with scrub oak, bunch grass, and loose stone. The first visit was made to this Peak on May 26, 1925, and while not a single live beetle was to be found at this time it was apparent from the large accumulations of dead beetles that this species had been congregating on the peak to hibernate for many years. The absence of live beetles at this time could probably be attributed to the fact that those individuals which have survived the winter successfully had migrated to the valleys. The masses of dead beetles under oak leaves, around the base of trees in the bunch grass, and under stones were several inches deep. Some of the beetles had nearly the natural color of living specimens, others were bleached almost white, and there were beetles with all intermediate shades.

Another trip was made to the peak on October 25 of the same year, and as in the case of the first visit, no live lady beetles were found. Apparently the severe dry season had reduced the population of the beetles in this area to the point where they were almost extinct as was the case with the Mexican bean beetle during the same period.

The last visit to the summit of the peak was made on September 29, 1929, at which time several hours were spent noting the action of the beetles. It was observed that "thousands" of beetles had accumulated on the peak. Mating was noticed in several instances, and the beetles when disturbed would become very active. During the observation several beetles were noticed flying in to join the great colony. No other species of Coccinellidae have been noted in this colony of the convergent lady beetle. The Mexican bean beetles placed on the peak in cages failed to survive the winter. The writer has been informed by U. S. forest rangers that they have noted colonies of *Hippodamia convergens* on higher mountain peaks of the Southwest than the Mosca Peak.

J. R. Douglass, *Assistant Entomologist, U. S. Bureau of Entomology, Estancia, New Mexico*

Note on a New Method of Determining Efficiency in Control. The usual method of determining the efficiency of any given control measure rests on the visual observation of the results. Generally, counts are made of the insects living and dead, and a ratio or percentage is obtained which gives a basis for statements on control. Occasionally estimates of reinfestation may be used for determining the effectiveness of control, but here too the data are accumulated by visual observations.

For three years the writers have been studying methods of combating the boxwood leaf miner. In this work several schemes of control were investigated and the results checked. The visual method of checking the efficiency of control was always relied upon. This system was used by the writers first because no other system seemed available, and also because it gave end-points in figures, which were results of the type usually sought—data of an objective kind and therefore easy to work with. Late in the course of the experimental work on fumigation with hydrocyanic-acid gas another method of determining results was accidentally discovered. This method, while hardly as exact for a final analysis as larval examination, rendered possible, early in the course of at least certain experiments, the making of better predictions than did visual observations. It consisted of auditory observation, and the examination for effectiveness of control was made by listening to the infested bush, rather than by looking at the fumigated larvae.

On sunny, fairly warm days in the spring, the healthy or vigorous larvae of the boxwood leaf miner move or squirm within their mines. This activity produces a faint but definite rustle in the bush which can be distinctly heard once an observer has accustomed his ear to note it. Larvae in infested bushes which, as later counts show, have been successfully fumigated do not produce this sound.

The value of this method of observation in estimating the efficiency of control of the boxwood leaf miner is very high, especially when the observations are made on spring-fumigated boxwood about one week to one month after fumigation. It is at this time a much more reliable criterion of the efficiency of a fumigation than larval examinations. This is true for the following two reasons: first, after fumigation, and apparently without regard to the success of the operation, boxwood leaf miner larvae are motionless when the leaves are opened for examination. Second, after the passage of a few days the stupefying effects of fumigation wear off and when leaves are then opened the larvae which eventually are going to die will squirm from the stimulus given them in opening the leaves.

This observation rests on the difference in behavior within unopened leaves of normal or nearly normal larvae and those which have had a killing dose of hydrocyanic-acid gas.

WILLIAM MIDDLETON and FLOYD F. SMITH, *U. S. Bureau of Entomology*

Suggestions for Use of Oil Sprays in 1930

The members of the Western Cooperative Oil Spray Project, comprising the experimental stations of California, Idaho, Montana, Oregon, Washington and British Columbia, and the United States Department of Agriculture, wish to make the following suggestions regarding the use of oil sprays on fruit trees in the Northwest, with particular reference to apples and pears. These suggestions are based on data accumulated from experimental work during the past three years.

OILS FOR DORMANT SPRAYS. 1. Dormant oil sprays should be applied in the spring before the bud scales separate and before the buds show green. Injury may result

if sprays are applied during the critical period (delayed dormant) of bud development. This period occurs between the time the buds first show green and the cluster bud stage.

2. There is no evidence that low temperatures following sprays applied in the spring during the dormant period result in injury.

3. Oils of relatively low sulfonation test (50–70) can be safely used.

4. Stable emulsions have proven safer than quick breaking emulsions.

Oils for Summer Sprays. The following suggestions are made to growers who are planning on using oil sprays for codling moth control.

1. The number of applications of summer oils should not exceed three, and under most conditions not more than two are advisable.

2. The use of oils alone has not given control of the codling moth. Oils should be used only in combination with lead arsenate or nicotine sulfate.

3. Oils in combination with lead arsenate should be applied during the height of the egg-laying period of the first brood, but if sulfur sprays are applied after the dormant period, no oil should be used in the first brood sprays.

4. Because of difficulty in removing spray residue, the oil-lead arsenate combination should not be used after July 25, but the oil-nicotine sulfate combination may be used after this date.

5. Oils ranging in viscosity from 65–75 have proven most satisfactory, except that for Newtowns or other varieties susceptible to oil injury the viscosity of the oil should not exceed 55.

6. Oils with a sulfonation test not less than 85 are satisfactory.

7. Caution: Oils in combination with lead arsenate should not be allowed to stand in pipes or spray tanks, but should be applied immediately after being mixed. Fruit sprayed with this combination after the spray has been allowed to stand in tanks or pipes for some time, can be cleaned only with great difficulty. This spray mixture is also ineffective in control.

8. For more specific recommendations regarding the use of oil, local authorities should be consulted.

The following members participated in the experimental work upon which the above suggestions are based:

British Columbia—E. P. Venables, entomologists; Max H. Ruhman, entomologist;

California—E. R. deOng, entomologist; Claude Wakeland, entomologists; Lief Verner, horticulturist.

Idaho—Claude Wakeland, entomologist; Lief Verner, horticulturist; C. W. Hungerford, plant pathologist; H. C. Magnusson, chemist; H. S. Snyder, chemist.

Montana—J. R. Parker, entomologist; W. C. Cook, entomologist; H. E. Morris; botanist; Jesse Green, chemist; S. H. Johnson, chemist.

Oregon—Don C. Mote, entomologist; B. G. Thompson, LeRoy Childs, Ento-Childs, entomologist; R. K. Norris, entomologist; R. H. Robinson, chemist; F. C. Reimer, horticulturist.

Washington—R. L. Webster, entomologist; Anthony Spuler, entomologist; F. L. Overley, horticulturist; J. R. Magness, horticulturist; W. A. Luce, horticulturist; E. L. Green, chemist; J. R. Neller, chemist; D. J. Crowley, plant pathologist.

U. S. D. A.—E. J. Newcomer, entomologist; M. A. Yothers, entomologist; D. F. Fisher, plant pathologist; E. L. Reeves, plant pathologist; H. C. Diehl, plant physiologist; C. P. Harley, plant physiologist; C. R. Gross, chemist; Jack E. Fahey, chemist; A. L. Ryall, pomologist; B. D. Ezell, horticulturist.

E. J. Newcomer, *Yakima, Washington, Chairman*
Anthony Spuler, *Wenatchee, Washington, Secretary*

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

FEBRUARY, 1930

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ANNUAL SCIENTIFIC MEETINGS: 1930–31, Cleveland; 1931–32, probably New Orleans; 1932–33, Chicago; 1933–34, undecided; 1934–35, probably Rochester.

The Editor was highly gratified with the responses to the questionnaire relative to leaded as compared to solid matter in the JOURNAL. Some 75 per cent of those addressed responded, a number with very helpful suggestions. There was one case where brother was arrayed against brother with, we trust, no serious consequences. The weight of evidence was in favor of the leaded matter, though a goodly proportion favored solid type. The problem will be given further consideration and it is hoped that those not circularized will consider themselves free to express their preferences to the Editor.

Entomologists generally can not but approve the recent appointment of the Federal Fruit Fly Board. The utilization of a group of experts is in accord with the best current practises. There is safety in a multitude of counselors. The personnel is highly satisfactory. It is no small undertaking to eradicate an insect after it has been found over a considerable portion of a state. Great responsibility attaches to all decisions in relation to such a problem. There are bound to be differences of opinion. The Board can accomplish much by giving careful consideration to all phases of the problem. There have been numerous changes, mostly minor, relative to fruit fly work since the appearance of the insect in Florida and others are to be expected. The method is more or less one of "trial and error." It is to be hoped that the project may be carried through to a successful completion. There is no one who can promise this, however, and the Federal and State authorities, under existing conditions, can not do less than prosecute the work vigorously until eradication is accomplished or its futility clearly demonstrated.

Review

A Handbook of the Mosquitoes of North America, Their Structure, How They Live, How They Carry Diseases, How They May be Studied, How They May be Controlled, How They May be Identified, by ROBERT MATHESON, pages I–XVII, 1–268, 24 text figures and 1 colored and 25 other plates, Charles C. Thomas, Springfield, Illinois, 1929.

This relatively small, well illustrated work attempts to give a practical comprehensive account of North American mosquitoes. The first chapter gives an admirable, well illustrated discussion of the structure of adults, larvae and pupae with special reference to characters which may be utilized in identifying the various species. The next chapter on Biology gives a detailed account of the habits of the common house or water barrel mosquitoe with interesting data on egg laying, larval habits and habitats, habits of the adults, including flight, time of activity, mating, longevity and hibernation. The next chapter is concerned with mosquitoes in relation to human welfare with special reference to the diseases of man and other animals which may be conveyed by these insects. There is an excellent chapter on problems in mosquitoe reduction, a brief discussion of methods of studying, collecting, rearing and preserving mosquitoes followed by a descriptive, systematic account with pertinent records as to distribution and habits of the various species. This is particularly valuable on account of the numerous admirable figures illustrating structural details and the series of tables for the recognition of both sexes and the separation of the larvae. There is a well selected bibliography and an excellent Index. The book itself is admirably printed and may well serve as a guide for similar publications in the future.

We consider this is a singularly happy, concise account which makes it relatively easy for entomologists or amateurs to become better acquainted with this important group. It is especially commended to public health officers, general biologists and laymen interested in public problems.

E. P. FELT

Current Notes

The Annual Meeting of the North Central States Entomologists will be held at Purdue University, Lafayette, Indiana, March 5th and 6th.

A. W. Morrill, Jr., was appointed Junior Entomologist, Bureau of Entomology, October 1, 1929, and assigned to the Dried-Fruit Insect Investigations, Fresno, Calif.

J. N. Tenhet, Bureau of Entomology, Chadbourn, N. C., was called to Washington, D. C., on November 15, to confer with M. C. Lane on the wireworm problem.

Alfred Weed, Agent, Bureau of Entomology, located at Madison, Wis., resigned November 19, to accept a position with John Powell & Co., Inc., New York City.

R. T. Cotton, Bureau of Entomology, spent October 21 in Toledo, Ohio, investigating the results of a commercial fumigation of a large elevator bin with ethylene oxide.

L. C. McAlister, Jr., Bureau of Entomology, who has been associated with Dr. F. H. Lathrop, at Cherryfield, Me., will take charge of investigations of the blueberry maggot.

Section 9207, Termite Protection, has just been added to the mandatory section of the new building code of the City of Honolulu, Hawaii, recently made a law.

Dr. Donald T. Ries was appointed Assistant Extension Entomologist at the Pennsylvania State College on September 15, 1929.

Prof. J. M. Robinson, Head Department of Zoology-Entomology, and Entomologist, Alabama Agricultural Experiment Station, studied the collection of Diabrotica in the U. S. National Museum at Washington, D. C., in early December.

George Wishart, of the Dominion Parasite Laboratory, Belleville, Ontario, and L. B. Baker, of the staff of the Japanese Beetle Laboratory, visited the Gipsy Moth Laboratory on November 25.

Immediately after the discovery of the pink bollworm in the Salt River Valley of Arizona, Messrs. Coad, Cassidy, Fenton, and Isler of the Bureau of Entomology, visited this district for a preliminary survey.

George G. Ainslie, Bureau of Entomology, who for a number of years was located at the field laboratory of the Division in Tennessee, was reinstated in November and assigned to duty at West Lafayette, Indiana.

It is thought that the low temperature of 4 degrees F., experienced in the vicinity of Ashville, N. C., on November 29, may have caused a rather high mortality of overwintering broods of the southern pine beetle.

Dr. F. H. Lathrop, Bureau of Entomology, who has been in charge of the Bureau's blueberry maggot investigations at Cherryfield, Me., has been transferred to Vincennes, Indiana, to be in charge of the field laboratory there.

Dr. D. P. Curry, Assistant Chief of Public Health, Panama Canal Zone, spent November 5 to 11 at the division of insects, Washington, D. C., studying mosquitoes and consulting with Mr. Greene on various problems in the classification of mosquitoes.

Dr. L. L. English, Associate Research Professor, Department of Zoology-Entomology, Alabama Agricultural Experiment Station, located at Spring Hill, Alabama, conferred with the authorities at the main office at Auburn, with reference to the citrus insect project, December 9 to 13.

At its meeting of June 29 the *Nederlandsche Entomologische Verseniging* elected as honorary members, in place of Chr. Aurivillius, of Sweden, and Th. Becker, of Germany, both deceased, Dr. Geza Horvath, of Budapest, and Dr. L. O. Howard of Washington.

Two appointments to the staff of the Cereal and Forage Division of the Bureau of Entomology were made in November. Edgar J. Udine was appointed Junior Entomologist, for duty at Carlisle, Pa., and John Caveney, Junior Entomologist, for duty at Arlington, Mass.

M. E. Phillips, of Ithaca, N. Y., formerly connected with the Division of Stored-product Insects of the Bureau of Entomology, and Mrs. Phillips, who, like her husband, is a graduate entomologist, visited the field laboratory at French Creek, W. Va., about November 1.

Dr. M. W. Blackman, of the New York State College of Forestry, at Syracuse University, has joined the staff of the Bureau of Entomology for a year, beginning October 1, and during the present winter is working in Washington, on the classification of Scolytid beetles.

Dr. H. J. Pack, entomologist on the staff of the Utah Agricultural Experiment Station, died January 5, following an operation for cancer.

Dr. A. G. Boving, of the taxonomic unit, Washington, D. C., has recently been elected a corresponding member of the Finnish Zoological and Botanical Society "*Vanomo*," Helsingfors, Finland. This society has only two other corresponding members—one in Sweden and one in Germany.

R. C. Brown, of the Gypsy Moth Laboratory, Melrose Highlands, Mass., returned to America on November 19 after an absence of two and a half years. During this time he has been studying and collecting parasites of the Gypsy moth in Central Europe.

Paul Guillement, Manager, Department of Agriculture of French Morocco, Angel Arrus, formerly Manager, Experimental Farm of Spanish Morocco, and Raymond Ricaud, American Trade Commissioner for the French Government at San Francisco, visited the Bureau of Entomology, field laboratory at Alhambra, Calif., November 1.

James R. Thompson, Jr., a graduate of North Carolina State College, who recently received the degree of Master of Science from the University of Tennessee, has been appointed Junior Entomologist, Bureau of Entomology, to assist with investigations at the Peach Insect Laboratory, Fort Valley, Ga.

Mr. R. D. Whitmarsh who has been Entomologist and Plant Pathologist with the Corona Chemical Division, Pittsburgh Plate Glass Company, since leaving the Ohio Experiment Station has been appointed Entomologist and District Manager with the Kay Laboratories, Inc. His present headquarters are Deland, Florida.

Recent visitors to the Department of Entomology, Agricultural Experiment Station, New Haven, Conn., include Dr. J. M. Ginsburg, New Brunswick, N. J.; Dr. Harrison Garman, Lexington, Kentucky; J. G. Conklin, Columbus, Ohio; and L. A. Stearns, Newark, Delaware.

J. C. Evanden, Bureau of Entomology, reports that experimental fall control against the mountain pine beetle in Montana has demonstrated that peeling the bark is not practicable at this time of the year, and that decking the logs and burning them had to be resorted to.

Dr. L. P. Wehrle who has been research assistant at Cornell University since he received his Doctor's degree, has been appointed Assistant Professor of Entomology in the University of Arizona. Dr. Wehrle entered on his duties at Tucson at the beginning of the second semester in February.

L. G. Baumhofer, Bureau of Entomology, has completed his field work on the pine tip moth at Halsey, Nebr. He reports that the eastern parasite of this moth, a species of Campoplex, has continued to increase markedly this year, and that improved conditions in the growth of the trees are already apparent.

Newell E. Good, who received his B.A. Degree from George Washington University last June, was appointed Junior Entomologist October 1, and assigned to Grain-Insect Investigations, with headquarters at Sligo, Md. He will make a special study of the biology of flour beetles. Mr. Good was formerly employed by the Bureau of Animal Industry.

Prof. W. B. Herms, Head of the Department of Entomology and Parasitology at the University of California, has accepted an appointment as visiting Professor in the department of Zoology and Entomology at Ohio State University for the summer term of 1930. He will conduct courses in medical entomology and direct graduate student problems in this field.

Prof. E. J. Dyce, a member of the Department of Entomology at the Ontario Agricultural College, Guelph, Canada, has been granted a leave of absence for one term in order to carry on certain phases of his investigations at Cornell University. Prof. Dyce hopes to complete his requirements for the Doctor's Degree in the near future.

Mr. A. W. Lopez, who received his Master's degree in entomology from the University of California in December 1928 is now Entomologist for the Philippine Sugar Association, Manila. His present headquarters are at the La Carlota Sugar Central, La Carlota, Occidental Negros, where his chief problem is an attempt to control white grubs of cane by biological means.

Dr. F. A. Fenton, of the Bureau's cotton-insect laboratory at El Paso, Tex., went to Washington, November 30 and spent several days in the taxonomic unit working on wasps of the subfamily Anteoninae. He also consulted the specialists in parasitic Hymenoptera regarding certain parasites of the pink bollworm, particularly some exotic species which may be introduced into this country.

Mr. L. E. Dills who spent the last year at Cornell has accepted a fellowship with the Crop Protection Institute. He will spend a month at the Boyce Thompson Institute in investigation and then leave for Lake Alfred, Florida, to carry on his experimental work there until the season opens in New York, when he will return to Ithaca to continue his investigations.

W. H. White, Bureau of Entomology, Washington, D. C., visited the bureau's field laboratory at Sanford, Fla., on November 7 for consultation regarding the work on the celery leaf-tier. On his return trip to Washington he stopped at Charleston, S. C., for consultation regarding investigations on the seed-corn maggot, and at Chadbourn, N. C., in regard to work on the strawberry weevil and strawberry root-louse.

Dr. E. A. Back, Bureau of Entomology, spent October 23 and 24 in New York, where, with representatives of the Bureaus of Agricultural Economics and Chemistry and Soils, and the New York Produce Exchange, fumigations of wheat in cars and

elevators were started with certain carbon disulphide-carbon tetrachloride mixtures and with ethylene oxide. This work was continued by Dr. Cotton on October 28, 29, and 30.

"The New York Farmers," a famous organization of well-known New Yorkers greatly interested in the advancement of agriculture, has established a medal to be awarded from time to time for outstanding achievement in agriculture. The first award of this medal was made in New York City January 21 and the recipient was Dr. L. O. Howard, for more than 50 years connected with the Bureau of Entomology of the Department of Agriculture.

Dr. J. M. Swaine, Entomological Branch, spent the greater part of October in the Maritime Provinces, where, accompanied by the Provincial Forester for Nova Scotia, and the foresters of two important pulpwood companies, he inspected insect injury to forest trees, particularly the outbreak of *Peronea variana* Fern. in the southern part of Cape Breton Island. Dr. Swaine reports that airplane dusting experiments for the control of forest insects, conducted in Ontario and Quebec in co-operation with the Air Service, have resulted in important progress being made in 1929.

Dr. Raymond L. Taylor, in charge of the Maine Forest Service Entomological Laboratory at Bar Harbor, spent several days in Boston in December visiting the Gypsy Moth Laboratory, Melrose Highlands, the Harvard Museum of Compara-Zoology. Cambridge and the Museum of the Boston Society of natural History in connection with the determinations of parasites and other insects reared principally from material infested by the birch leaf mining sawfly (*Phyllotoma nemorata*) and from a new birch case-bearer, *Coleophora salmani* Hein.

It is reported that on November 26 three employees of a company at Fresno, entered a fumigation chamber too soon after a fumigation with hydrocyanic acid and were disabled by the gas. Members of the Fire Department, using a pulmotor, worked over one of the men for 40 minutes before he regained consciousness. This accident and the explosion of carbon disulphide at Dinuba, mentioned in the monthly letter of the Bureau of Entomology, for October, help to promote the acceptance of ethylene oxide for use in fumigations.

The 66th Annual Meeting of the Entomological Society of Ontario was held at the University of Western Ontario, in London, on Nov. 21 and 22. The meeting proved to be one of the best attended and most successful meetings in the history of the society, and the programme contained a long list of interesting papers dealing with a wide variety of entomological subjects. A banquet was given to members of the Society and guests, by the University, on the evening of Nov. 21, and this was followed by a public address entitled "The Trend of Ecological Research in European Corn Borer Investigation," by K. W. Babcock, of the United States Bureau of Entomology.

On November 1, Octava Piel, S. J., of the Museum of Natural History of Zi-Ka-Wei, Universite l' Aurore, Shanghai, China, visited the Japanese-Beetle laboratory at Riverton, while on his way to China. His visit was advised by Dr. P. Vayssiere, of Paris, who was at this laboratory in the summer of 1928. Father Piel was much interested in the work of the parasite division of the laboratory. He has lived in the district in China where our field collectors obtained Tiphia, and has a large series of these parasites which he very kindly offered for study here. They were accepted, and it is felt that Father Piel will be of further assistance to the bureau in obtaining

certain desired weather reports of the same region. He spent November 6 to 19 studying the National Collection of Hymenoptera and consulting with the bureau hymenopterists in Washington.

On the evening of December 17th, Prof. Herbert Osborn was honored at a banquet given at the Chittenden Hotel, Columbus, Ohio, by his colleagues and associates of the Ohio State University and the Ohio Experiment Station. The dinner was given in recognition of the completion of 50 years continuous service as an investigator and teacher in Zoology and Entomology. During the evening toasts were given by Dr. George Rightmire, President of the University, Dr. W. O. Thompson, President Emeritus, Dean William McPherson, Dean of the Graduate School and Dr. R. C. Osburn, Head of the Department of Zoology and Entomology. During the evening a beautifully illuminated testimonial was presented to Prof. Osborn express ing the love and esteem in which he is held by his associates at the Ohio State University.

The seventh annual meeting of the Entomological Society of Pennsylvania was held at Harrisburg, Pa., on January 21st in conjunction with the State Farm Products Show. J. R. Stear discussed investigations of native parasites of the Oriental fruit moth; S. W. Frost told of plans for the baiting of a large peach orchard; and H. E. Hodgkiss spoke of attempts at the control of this species by Pennsylvania peach growers. C. H. Hadley explained the appearance and habits of the Asiatic beetles, and showed their present distribution. T. L. Guyton discussed the present status of the European corn borer in Pennsylvania, and H. N. Worthley gave some results of experimental work with this insect. C. C. Hill presented the results of the 1929 surveys of Hessian fly infestation, explaining the present low numbers of this pest in Pennsylvania. After dinner S. W. Frost delighted the members with a talk on his recent sojourn in the Canal Zone, illustrated by moving pictures taken during the trip. The following were present: A. B. Champlain, E. H. Dusham, S. W. Frost, J. K. Gould, T. L. Guyton, C. H. Hadley, C. C. Hill, H. E. Hodgkiss, F. L. Holdridge, J. O. Pepper, J. S. Pinckney, D. T. Ries, G. B. Sleesman, A. W. Smith, J. R, Stear, G. B. Stichter, E. J. Udine, H. N. Worthley, J. N. Knull.

A Federal Fruit Fly Board consisting of Dr. W. C. O'Kane, State Entomologist of New Hampshire, Chairman; Dr. P. J. Parrott, Entomologist of the New York Experiment Station; Dr. J. J. Davis, Professor of Entomology, Purdue University; Dr. W. P. Flint, State Entomologist of Illinois and Dr. George A. Dean, Professor of Entomology, Kansas State Agricultural College, has been appointed by Secretary of Agriculture Hyde and charged with the consideration of all biological and entomological questions and the determination of policies in the actual fruit fly eradication work and the supervision and control of Federal expenditures in the eradication effort. Members of the Board have secured temporary leaves of absence from their institutions and are prepared to serve as long as needed. The headquarters of the Board will be at Orlando, Florida. It is stated that the Board will serve as an immediate contact between the Plant Quarantine and Control Administration and the Eradication forces in Florida and will relieve the administration offices in Florida of the necessity of giving attention to grievances and recommendations of growers and shippers. Dr. Wilmon Newell who has been in charge of the Federal work in Florida since last April will remain in the position of administration officer.

Horticultural Inspection Notes

Mr. B. F. Boillot has been appointed assistant to the Plant Commissioner in the State Board of Agriculture of Missouri.

Mr. Alfred S. Mills, Inspector of the Plant Quarantine and Control Administration was transferred from New York to San Juan, Porto Rico, effective December 15, 1929.

Recent requirements placed by the State of Oklahoma with respect to the admission of white seed potatoes include special certification relating to varieties, quantity, transportation injury, storage injury, diseases, etc.

Mr. E. R. Sasscer, in charge, Foreign Plant Quarantines, of the Plant Quarantine and Control Administration, visited the ports of New York and Boston, January 8 to 11, inclusive, for the purpose of conferring with the inspectors in charge at those ports.

On December 9, 1929, the State of Alabama issued Regulation No. 28, under which the movement of citrus fruits and certain plants from Florida into Mobile County, Alabama, is prohibited on account of the Florida red scale and scaly bark.

The Illinois alfalfa weevil quarantine was amended November 29, 1929, adding certain new territory to the areas in the Rocky Mountain States from which alfalfa hay and other products were prohibited admission into Illinois on account of that weevil.

Specimens of the spruce gall aphid, *Adëlges* sp. have been found during the past season on Colorado Blue Spruce trees which have been moved from the native forests of Colorado. This is reported to be a new insect for Nebraska and an effort is being made to see that it does not obtain a foothold there.

The Arkansas State Plant Board, on November 22, modified State Quarantine No. 7 and Rules 60 and 60-a, promulgated thereunder, in order to bring the State quarantine on account of the Mediterranean fruit fly and the Dictyospermum scale into line with the Federal quarantine regulations.

On December 23, 1929, the State Department of Texas issued a quarantine proclamation on account of the sweet potato weevil, establishing certain areas of that State as pest free zones, and prohibiting the importation of sweet potatoes into those zones from without except under permit of the Commissioner of Agriculture.

The annual report of the State Nursery Inspector of Nebraska shows that 157 nurseries were inspected in the State during the past season and that these nurseries had approximately 1000 acres of growing stock. No new or serious insect pests were found in the nurseries except the spruce gall aphid and the spruce Tortrix.

An insect pest of spruce which prior to 1929 had been found in only one locality in Nebraska, has been found rather commonly at Lincoln and Omaha during the past inspection season according to Mr. L. M. Gates. The insect is known as the Spruce Tortrix, *Olethreutes abietana* Fernald, and seems capable of doing serious injury to spruce.

The National Plant Board met at Orlando, Florida, on January 11. The membership of the Board as at present constituted, consists of: W. C. Jacobsen and O. C. Bartlett, Western Plant Quarantine Board; G. A. Dean and A. G. Ruggles, Central Plant Board; W. C. O'Kane and W. A. McCubbin, Eastern Plant Board; and R. W. Leiby and R. W. Harned, Southern Plant Board.

Miss M. A. Thompson of the Plant Quarantine and Control Administration has prepared a digest of State quarantines now in effect, and this digest is expected to be ready for distribution to State quarantine officers and others interested, early in March. The new digest is being prepared in a loose leaf form in order that amendments can conveniently be inserted from time to time.

During December, a resolution was passed by Congress and signed by the President, making an emergency appropriation of $1,290,000 available for continuing the enforcement of the Mediterranean fruit fly quarantine. Of this sum, $290,000 was for the purpose of replacing transfers which had been made by the Secretary of Agriculture from other Plant Quarantine and Control Administration funds to the fruit fly project.

Inspections by Prof. Don B. Whelan from the Entomology Department of the University of Nebraska during the past two seasons have failed to confirm the reported presence of the alfalfa weevil in Scotts Bluff County, Nebraska, and, according to L. M. Gates, State Nursery Inspector, at least two outside States have revoked their quarantines against alfalfa from that county on the basis of Prof. Whelan's reports.

Secretary Hyde announced on December 30, a revision of the Federal pink bollworm quarantine regulations effective January 1. The regulations as revised, authorize, "under certain safeguards, the issuance of permits for the interstate movement of cotton samples and of compressed and baled lint or linters from the regulated areas of western Texas, New Mexico, and Arizona, without fumigation, when such samples, lint, or linters have been produced in a county within which and within five miles of which no pink bollworm infestation has been found for the two preceding crop seasons." Five amendments to the regulations as issued July 9, 1927, have been promulgated since that date and are incorporated in the revision.

Mr. George W. Nelson, of St. Paul, Minnesota, was appointed as agent in the Plant Quarantine and Control Administration on December 9, to take the place of Mr. E. J. McNerney as transit inspector at Nashville, Tennessee, Mr. McNerney being transferred to the European corn borer project and temporarily detailed to Chicago at that time.

Circular 169, recently published by the Department of Agriculture of New Jersey, gives the results of the ninth year's work against the gipsy moth in that State. Only one gipsy moth colony was found during the fiscal year as compared with five colonies and seven egg masses during the previous season, and 855 colonies and 3,003,039 egg masses found in the fiscal year 1920–21.

The barberry eradication work of the United States Department of Agriculture which has heretofore been carried on by the Office of Cereal Crops and Diseases of the Bureau of Plant Industry, has been established as a separate office of that Bureau. Mr. Fred C. Meier, extension pathologist of the Federal Extension Service, has been placed in charge, with Dr. E. C. Stakman of the University of Minnesota, appointed to act in an advisory capacity. Mr. Meier has had experience in food products inspection service of the Bureau of Agricultural Economics and since 1922 has been promoting extension programs in plant disease control. He holds the B. S. and A.M. degrees from Harvard University.

Administrative instructions were issued by the Plant Quarantine and Control Administration January 8, slightly modifying certification requirements under the Japanese beetle and the Asiatic beetle quarantines. The effect of the amendment was to eliminate the requirement that screens must be placed in the bottom

of each pot used for plants which are to be shipped interstate from nursery and green house premises in Class II and Class III. The plants concerned must be potted in certified soil and placed in beds the soil of which has been treated with lead arsenate, and experience with this method of treatment indicates that it constitutes a complete safeguard against infestation.

Recent plant quarantine regulations issued by the State Board of Horticulture of Oregon include Quarantine Order No. 16, restricting the entry of clover seed from all other States on account of the leaf and stem nematode; Quarantine Order No. 17, prohibiting the entry of cuttings and roots of the hop from Canada and all parts of the United States except California, on account of the downy mildew of the hop; Amendment No. 1 to Quarantine No. 13, requiring fumigation of potatoes entering from California, Florida and Texas, on account of potato tuber moth and root knot nematode; and Amendment No. 1 to Quarantine No. 7, pertaining to the alfalfa weevil, providing for the entry of alfalfa meal under certain restrictions.

Orders issued by the Plant Quarantine and Control Administration with reference to the Mediterranean fruit fly quarantine regulations during the last two months include the following: PQCA-253 "Authorization of Transportation of Florida Host Fruits and Vegetables from the District of Columbia to Nearby Points in Virginia"; PQCA-254 "Movement Authorized of Sterilized Host Fruits and Vegetables from Florida to Other Southern and Western States"; PQCA-255 "Sterilization of Oranges, Tangerines and Satsumas by Use of Heat under Mediterranean Fruit Fly Regulations"; PQCA-256 "Release of Certain Areas Designated as Infested Under the Mediterranean Fruit Fly Quarantine Regulations"; PQCA-257 "Instructions to Inspectors Re Interstate Shipments of Celery from Florida"; PQCA-258 "Containers Authorized for Interstate Movement of Florida Host Fruits and Vegetables."

The European corn borer quarantine was revised on December 16, 1929, effective immediately, enlarging the area under regulation to the extent of 655 townships, of which 209 are in the two-generation area and 446 in the one-generation area. In addition, seven townships in New Hampshire, which were formerly in the one-generation area have been transferred to the two-generation area. Changes in the requirements affecting the interstate movement of the restricted articles include (1) placing the limitation on the quantity of cleaned shelled corn which may be shipped without certification or other restriction at 25 pounds to the package instead of two pounds as heretofore; (2) allowing free movement of sweet corn on the cob from New York City during the months of May and June, the period during which no sweet corn produced within the regulated area reaches that city; and (3) removing the special restriction applying to Maine as to entry of the restricted articles from the regulated areas outside that State.

The agricultural appropriation bill for the fiscal year ending June 30, 1931, as passed by the House of Representatives, carried $720,000 for the enforcement of foreign plant quarantines, an increase of $180,000 over the funds for the present year; $647,500 for gipsy and brown-tail moth work, an increase of $80,000; $1,000,000 for European corn borer control, an actual increase of $52,000; $475,000 for the enforcement of the Japanese beetle, and the Asiatic beetle quarantines, an increase of $208,000; and $65,000 for the prevention of spread of the date scale, a decrease of $21,700. The bill also includes a new item of $40,000 for the establishment of a system of transit inspection at strategic points in the United States, for the enforcement of domestic plant quarantines; of this amount $20,000 was derived from a reduction in funds for white pine blister rust and phony peach disease control work, and the remainder constitutes an increase of $20,000 over funds available for the current fiscal year.

Apicultural Notes

W. J. Nolan, Bureau of Entomology, attended the meeting of the West Virginia Beekeepers' Association, at Martinsburg, W. Va., on November 29.

Dr. Warren Whitcomb, Jr., Bureau of Entomology, of the Southern States Bee Culture Field Laboratory, Baton Rouge, La., attended the meetings of the Alabama State Beekeepers' Association, at Montgomery, Ala., on November 7 and 8.

Mr. L. T. Floyd, Provincial Apiarist, Department of Agriculture, Winnipeg, Manitoba, was one of the principal speakers at the Alabama Beekeepers' Association meeting in Montgomery, November 7 and 8. Dr. Warren Whitcomb of the U. S. Regional Beekeeping Laboratory located at Louisiana State University, Baton Rouge, was another speaker before the Association. Mr. G. Sadler, Superintendent of the Southeastern Division of American Railway Express Company, Atlanta, Georgia, was the guest of the Beekeepers' meeting also.

The thirty-ninth Annual Convention of the Illinois State Beekeepers' Association was held at Springfield, Illinois, on December 3rd and 4th, 1929. The speakers appearing upon the program were as follows: J. F. Diemer, Liberty, Missouri; Charles Kruse, Paris, Illinois; G. H. Cale and M. G. Dadant, Hamilton, Illinois; M. J. Deyell, Medina, Ohio, and V. G. Milum, of University of Illinois. The association voted to affiliate with the American Honey Producers' League and to financially support the American Honey Institute.

The Beekeeping Division of the Department of Entomology, University of Illinois, will offer a short course for beekeepers in connection with the Annual Farm and Home Week of the Illinois College of Agriculture, during the week of January 13th to 17th. V. G. Milum, Apiculturist of the University will be in charge of the short course, assisted by M. G. Farrar, formerly of the University of South Dakota, but now with the Illinois Natural History Survey, and G. H. Cale, associate editor of the *American Bee Journal*, Hamilton, Illinois.

E. L. Sechrist, Bureau of Entomology, spent some time in October in New York State, where, with the collaboration of Dr. E. F. Phillips, of Cornell University, cooperating beekeepers were selected for work in that State on the management of bees as related to the cost of production of honey. This is part of a similar program which was begun in 1928 in the Intermountain States and is now being extended to the region which produces white-clover honey. Mr. Sechrist also went to Ohio and Michigan, to begin similar work there, while R. S. Kifer, of the Bureau of Agricultural Economics, which is cooperating with the Bureau of Entomology, on this work, left at the same time to select cooperators in Iowa, Wisconsin and Minnesota.

Reorganization of the Kentucky State Beekeepers Association was effected at an enthusiastic meeting of approximately sixty beekeepers, orchardists and others interested at the University of Kentucky, Thursday, January 30. G. W. Hurst, of Flemingsburg, was made president; Lander Skinner, of Winchester, vice-president; and W. A. Price, State Entomologist and head of the Department of Entomology and Botany of the Kentucky Agricultural Experiment Station, secretary and treasurer. The constitution and by-laws of the old organization were readopted and resolutions condemning the Capper-Cole corn sugar bill and urging the need of adequate legislation for the combating of American foulbrood in the State were

passed. Dr. V. G. Milum, secretary of the Illinois State Beekeepers Association assisted in the program. D. C. Babcock, of Medina, Ohio, and Ben Niles, secretary of the Kentucky State Horticultural Society also spoke during the meeting.

Dr. Robert F. Martin, Director of the Department of Markets, Service Technique of Agriculture, of Hatii, and Mr. Louis DeJoie, also of the Department of Markets, Haiti, visited the Bee Culture Laboratory on November 2, in order better to acquaint themselves with the proposed United States grades for honey. The Government of Haiti has recently established standards for coffee, and honey will be the next product for which the Government expects to establish standard grades. Haiti is an important honey-producing country, as it abounds with a number of nectar-yielding plants from which unusually good honeys are derived. The beekeeping industry in Haiti has received heretofore little or no assistance from the Government, and it is expected that with Government recognition and assistance the development of the excellent beekeeping resources will naturally follow.

Notes on Medical Entomology

W. G. Bruce, Bureau of Entomology, of the field laboratory at Fargo. N. D., arrived in Dallas, Tex., November 19, to collaborate with Mr. Laake and others in work on the cattle grub.

On Nov. 23–24, while en route to Ottawa from the Entomological Society Meeting in London, Mr. C. R. Twinn, Entomological Branch, visited the Ontario Agricultural College at Guelph, Ont., where, with Prof. L. Caesar, Provincial Entomologist, he looked into a mosquito control project in the vicinity of Puslinch Lake.

Dr. Alfons Dampf, Chief Entomologist and Head of the Department of Research, Mexican Department of Agriculture, has spent in the month of December a fortnight in the State of Guerrero, studying the distribution of bloodsucking insects in relation to the skin disease called "Mal del Pinto." Simulids and Ceratopogonids are suspected to be the carriers of the unknown germ.

F. C. Bishopp, Bureau of Entomology, left Washington, November 8, for a trip through the Southwestern states. Stops were made at Dallas, Uvalde, Sonora and Menard, Tex., for conferences with employees stationed at these points. The farthest western point reached was Coachella, Calif., where investigations of the eye gnat, a species of Hippelates, are being carried on. On his return trip a stop was made at Phoenix, Ariz., and a short trip of inspection in company with T. P. Cassidy and F. A. Fenton was made to the cotton area in the Salt River Valley, which was recently found infested with the pink bollworm. Mr. Bishopp returned to Washington, November 26

JOURNAL
OF
ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

VOL. 23 APRIL, 1930 No. 2

Proceedings of the Forty-Second Annual Meeting of the American Association of Economic Entomologists

(Continued)

Wednesday Morning Session, January 1, 1930

The session convened at 9:50 a. m., President T. J. Headlee presiding.

PRESIDENT T. J. HEADLEE: The first paper is by Harry R. Bryson.

A STUDY OF FIELD PRACTICES AS RELATED TO WIREWORM INFESTATIONS (ELATERIDAE)[1]

By HARRY R. BRYSON, *Kansas Agricultural Experiment Station*[2]

ABSTRACT

Studies conducted at Manhattan, Kansas, from 1924 to 1929, inclusive, show that the percentage of corn plants injured by wireworms is influenced by the rate, date, and method of planting corn. Corn grown on land which had been cropped continuously to corn for 19 years showed less wireworm injury than that grown in various rotations. The studies indicate further that the sequence in which crops are grown in rotations, as well as the tillage methods employed in the preparation of the seed-bed, influence the amount of wireworm injury that may be expected.

Investigators in the field of subterranean insects are interested in the farm practices which influence the severity of infestations of insects attacking the roots of staple crops. The habits of wireworms are of particular interest in relation to field practices because of the difficulties involved in developing satisfactory methods for their control.

While conducting investigations pertaining to the life history and feeding habits of the true wireworms at this station, the writer had an opportunity to make observations and infestation counts, covering a

[1]Contribution No. 379, from the Department of Entomology.

[2]The writer wishes to express his appreciation to Prof. Geo. A. Dean, and to Prof. J. W. McColloch for their kindly suggestions in the preparation of this manuscript and to members of the Department of Agronomy at the college for their cooperation in making possible the field studies described herein. Acknowledgment is also made to Mr. Sam G. Kelly, student assistant, for his worthy assistance.

period of six years, from 1924 to 1929, inclusive, on corn grown under controlled conditions at the college farm on land subjected to various cropping practices. These studies were extended over a period of years because, first, many of the wireworms require from three to five years in which to complete their life histories, and second, because severe infestations do not ordinarily occur successively for a period of years at this station.

The following discussion is not presented as an exhaustive study of cropping practices and their relation to the wireworm injury problems, but rather as a progress report on preliminary studies that may prove valuable to workers interested in control methods for this group of subterranean insects.

METHODS. The studies recorded in this paper were begun in the spring of 1924 on plots and fields subjected to various cropping systems and different cultural methods. An effort was made to determine the effect which the date, method, and rate of planting corn would have upon the per cent of wireworm injury resulting under these conditions. Plots on which corn had been grown continuously for 19 years were compared with those on which had been practiced different systems of crop rotation. Notes, recording observations and infestation counts, were also taken on corn planted on plots handled according to various tillage practices in the preparation of the seed-bed.

Corn, observed on the date and method of planting, was planted at ten-day intervals, beginning with March 31 and ending May 20. One series each was listed, planted in an open furrow, and on the surface. This arrangement afforded excellent opportunity for observations to be made on corn planted according to these methods on the dates indicated.

The hills were spaced in the row from four to thirty-two inches apart at intervals of four inches in the rate of planting tests, each of which was replicated twice. These series were planted approximately on the same date each year, except in 1929, when a rate and date of planting plot was introduced into the series. The rate and date of planting will be discussed separately from the regular rate of planting.

The continuous corn area consisted of thirteen one-tenth acre plots treated with various fertilizers and planted to corn continuously for a period of 19 years. For the purpose of these studies, the counts on individual plots are not recorded separately since the series is treated as a single field. Data were also taken on a series of plots, planted the same date but subjected to different dates of plowing in the preparation of the seed-bed in order to determine, if possible, the effect of such practices upon the amount of wireworm injury.

The total number of plants and also the injured ones were counted in each plot or series of plots, each year except in 1924, when only the total number of hills and the injured hills were counted. All counts were made when the corn measured four or five inches in height and, consequently, were not taken on the same date each year. The stage of growth at which counts were taken varied but little one year after another. Only injured plants, which appeared above the surface, were counted. No data were taken on the number of kernels destroyed by the larvae, or the injured plants which never appeared through the soil. In 1929, the wireworms were dug out of the hills in a series of badly infested plots on which were practiced different tillage methods and retained for rearing purposes.

PRESENTATION AND DISCUSSION OF DATA. Nature of Injury. Wireworm injury to corn can be detected in most instances by the characteristic appearance of the tip or center leaf. This leaf is usually the first to show wilting after which it dries and turns brown, while the remainder of the leaves remain green. In cases of severe injury, the remaining leaves undergo a similar change. This characteristic injury is most noticeable when the plants are four or five inches in height and is caused by the larvae attacking the plants above the first node from which the permanent roots are produced. A small, round hole is eaten into the center of the stalk, thus cutting off the water and food supply from the central parts above the point of injury. The plant wilts down only when the entire center of the stalk is destroyed. Observations show that very few plants, if any, actually recover from even the slightest injury. The plants showing injury were dug up and examined in order to be certain that they were injured by wireworms. This process was repeated when a new plot was encountered and at definite intervals during the count. In practically every instance, the characteristic injury or the larva was found; hence, every care was exercised to discriminate against injuries effected by agencies other than wireworms. Observations show that one wireworm is sufficient to injure an entire hill of corn, since a single larva does not always feed upon one plant until it is destroyed but may move to other stalks in the hill and attack them.

Further observations also show that a single larva may move down the row in which the corn is drilled and kill four or more plants spaced 14 inches apart. This is evidenced by the first plant being dead, the second partly wilted, the third with the central leaf wilted, while the central leaf on the fourth is beginning to wilt. If the last plant is examined, the wireworm invariably can be found. In some instances

where seed corn lies in cold, wet soil from ten to fourteen days before germinating, wireworms attack the seed; therefore, injury to the seed is less likely to occur when its germination is not retarded.

Rate of Planting.—The data, herein presented to show the effect of planting corn various distances apart, indicate, in general, that the per cent of injury increases as the distances between the plants are increased. Plantings were made approximately the same date each year and the counts were taken at the same stage of growth.

An examination of the data presented in Table 1 shows that the hills were counted in 1924 while the plants were recorded for the remaining years. In computing averages, the number of hills are considered as plants, because in this particular instance there was only one stalk to the hill. In any event, the relative amount of injury occurring at the various distances bears the same relation to each other.

In 1925, there were two plants to the hill; in 1927 to 1929, each hill had but one. However, the data taken in 1928 and 1929 were based upon two rows out of the four series. The area devoted to the rate of planting plots was not located in the same place on the farm each year but the sequence of crops on the land, previous to being planted, was the same. Approximately three years elapse before the plot is again planted on the same soil. An effort is made to keep the plots on the same soil type so that the data obtained from year to year are comparable. Data taken in 1926 were omitted from Table 1 because of the inaccuracy involved in distinguishing a few wireworm-injured plants from severe injury caused by cutworms.

If the number of plants and the number of injured ones be determined for each distance each year and the percentage of injured plants calculated, it is possible to show the effect of different spacings upon the per cent of injury. An examination of Table 1 shows that 1924 and 1925 were years in which there occurred the heaviest wireworm injury.

The "average column" at the extreme right in the table was computed by adding the total number of plants for all years and the number of injured plants for the same years and from these calculating the percentage of injury for each spacing for five years.

A further examination of the average column shows that the lowest injury, one and forty-three-hundredths per cent, for the five-year period, occurred where corn was planted four inches apart in the row. The space between the rows was the regulation distance of 42 inches used in planting corn in the general fields at Manhattan. Plants spaced 8, 12 and 16 inches apart showed injury resulting from the attacks of wireworms to the amount of 2.01, 1.88 and 1.98 per cent injury, respectively.

TABLE 1. PERCENTAGE OF WIREWORM INJURY TO CORN PLANTED AT DIFFERENT RATES FOR A FIVE-YEAR PERIOD

Distance Apart	1924			1925			1927			1928			1929			Per cent of Injury for the 5-Year Period
	Total Plants	Injured Plants	Per cent Injured	Total Plants	Injured Plants	Per cent Injured	Total Plants	Injured Plants	Per cent Injured	Total Plants	Injured Plants	Per cent Injured	Total Plants	Injured Plants	Per cent Injured	
4 inches	2182	108	4.77	4312	17	.39	2353	1	.04	1091	1	.09	637	24	3.77	1.43
8 inches	1174	84	7.15	2422	17	.70	1152	5	.43	515	3	.58	1081	19	1.76	2.01
12 inches	797	54	6.77	1635	4	.24	775	5	.65	327	3	.91	722	14	1.94	1.88
16 inches	608	55	9.05	1223	7	.57	589	0	.00	328	1	.34	1139	14	1.23	1.98
20 inches	483	47	9.73	1037	3	.29	541	2	.37	222	1	.45	427	22	5.13	2.77
24 inches	395	70	17.72	844	7	.83	475	2	.42	175	1	.56	295	26	8.81	4.85
28 inches	343	62	18.08	700	10	1.43	382	4	1.05	161	0	.00	94	15	15.95	5.42
32 inches	280	67	23.93	640	7	1.09	406	1	.24	128	0	.00	91	14	15.38	6.16

Those planted 20 inches apart showed a definite increase over the amount of injury recorded for the shorter distances.

The plants spaced 24 inches apart indicated a marked injury of 4.85 per cent as compared with 2.77 per cent in the 20-inch planting. The data show a gradual increase in the percentage of wireworm injury beginning at the 20-inch spacing and ending with the 32-inch planting. This increase is attributed to the greater population of wireworms to the plant in the sparsely planted rows. Observations also indicate that injury is greater on drilled corn than on that which is checked. The total population of wireworms to the plot would be approximately the same for all plots. From the data submitted, one could assume that 20-inches apart would be the longest distance at which single plants should be spaced in order to avoid severe wireworm injury to the stand.

It is interesting to note that approximately five years intervened between the years on which severe wireworm infestations occurred. In some of the rearing work conducted at this station, the writer has found that the life histories of some of the collected larvae belonging to the genus Melanotus, which attack the roots of corn, extend over a period of four or five years. Further investigations will be necessary to determine whether or not there is any significance in this apparent relationship between the occurrence of wireworm infestations and the length of time required for the insects to complete their life histories. The temperature and moisture conditions in the spring of 1928 and 1929 were similar at the time of planting.

Rate and Date of Planting.—Two series of plots were introduced into the regular rate of planting tests in the spring of 1929. One planting was made on May 2, while the other was planted May 18. The plantings on each date consisted of a series of five plots each with spacings of the plants in the rows ranging from eight inches in the first plot to 24 inches in the fifth one. The two series were not replicated. The results of this test are shown in Table 2.

Table 2. Percentage of Injury to Pride of Saline Corn Planted at Different Rates on May 2 and May 18

Distance Apart	Planted May 2, 1929			Planted May 18, 1929		
	Total Plants	Injured Plants	Per cent Injured	Total Plants	Injured Plants	Per cent Injured
8 inches	475	3	.63	575	0	0
12 inches	315	3	.95	253	0	0
16 inches	218	4	1.83	255	0	0
20 inches	193	6	3.11	195	1	.52
24 inches	144	7	4.86	159	2	1.26

An examination of the data presented in Table 2 shows that the time of planting influenced the amount of wireworm injury present.

Although 16 days intervened between the two plantings, there was very little difference in the height of the plants on May 27th, when the counts were made.

The percentage of injury for plantings made on May 2 increased from .63 per cent for corn spaced eight inches apart to four and eighty-six-hundredths per cent at 24 inches, with a marked increase in injury beginning at the 20-inch spacing. A similar increase for corn planted May 18 as a result of spacing is shown in column six. Since the plots were planted in close proximity to each other, with other environmental and edaphic factors similar, the variation in injury to either of the plots resulted after the date on which the counts were made.

Time and Method of Planting.—A study of the work done over the five-year period to determine the effect of the time and method of planting corn upon the amount of wireworm injury shows a definite relationship existing between these factors and the percentage of injury. Table 3 gives a complete record of the counts made for five years of investigational work. Records were kept on the plots planted by the different methods at ten-day intervals, beginning March 31 each year and ending May 20. The percentage of injury is calculated for each date of planting for each year. The percentage of injury for each date of planting over the five-year period is recorded in the last column in Table 3.

A careful examination of Table 3 indicates that, for the five-year period, wireworm injury was more severe on corn planted April 10 and least severe on that planted May 20, irrespective of the method of planting used. Corn planted March 31 also suffered considerable injury. These facts show more vividly that slow germination and retarded growth are conducive to wireworm injury. The data in Table 2 also show that corn planted on May 18 revealed less injury than that planted on May 2. Observations also indicated that germinating kernels were injured when the corn was planted at the time wireworm attacks are most likely to occur, thus reducing the number of stalks in the row.

A comparison of the percentage of wireworm injury to which listed, open furrow, and surface-planted corn were subjected, shows that listed corn suffered least from the attacks of wireworms. The fact that the soil is thrown up in the form of a ridge reduces the possibility of attack because the seed is placed below the level frequented by the larvae at this time of year. Miles and Petheridge (1927) found in England that wireworms, *Agriotes obscurus*, are seasonal in their movements in the soil, coming upward in September, October, March, April and May, and going downward through autumn, winter and spring. From pre-

TABLE 3. PERCENTAGE OF INJURY TO CORN IN THE DATE AND METHOD OF PLANTING TESTS

Date	Total Plants	Injured Plants	Per cent Injury	Total Plants	Injured Plants	Per cent Injured	Total Plants	Injured Plants	Per cent Injured	Total Plants	Injured Plants	Per cent Injured	Total Plants	Injured Plants	Per cent Injured	Per cent of Plants Injured for Five-year Period
							Listed									
March 31	172	6	3.49	180	0	0	174	2	1.15	76	0	0	120	0	0	1.11
April 10	170	16	9.41	177	0	0	167	0	0	154	3	1.94	96	0	0	2.49
April 20	176	13	7.38	186	1	.53	170	0	0	167	0	0	94	3	3.19	2.15
April 30	177	5	2.82	176	0	0	147	2	1.36	181	0	0	136	1	.74	.98
May 10	177	3	1.69	205	1	.48	119	2	1.68	149	0	0	151	3	1.99	1.12
May 20	174	0	0	180	0	0	181	0	0	No record			136	1	.74	.15
							Open Furrow									
March 31	170	30	17.64	173	2	1.15	175	0	0	118	0	0	150	1	.66	4.25
April 10	164	31	18.90	116	0	0	166	0	0	171	1	.58	119	3	2.52	4.75
April 20	168	20	11.90	159	0	0	174	0	0	166	0	0	114	0	0	2.59
April 30	166	17	10.24	159	3	1.68	135	0	0	192	1	.53	116	1	.86	2.86
May 10	108	31	28.70	190	0	0	117	0	0	182	0	0	129	1	.77	4.41
May 20	94	9	9.58	116	0	0	153	0	0	No record			No record			2.48
							Surface									
March 31	175	69	39.43	188	1	.53	195	0	0	76	0	0	231	3	1.30	8.44
April 10	168	75	44.64	166	0	0	188	0	0	154	3	1.83	142	4	2.81	10.12
April 20	172	22	12.77	195	2	1.03	204	0	0	169	0	0	115	4	3.48	3.28
April 30	173	12	6.93	185	0	0	173	0	0	181	0	0	120	2	1.66	1.68
May 10	164	6	3.66	199	2	1.00	158	0	0	149	0	0	151	4	2.65	1.46
May 20						.48	186	0	0	No record			125	2	1.60	1.31

liminary diggings made at Manhattan in grasslands, the writer has found that wireworms are very close to the surface during March, April, and early May.

In 1924 and 1929, the greatest injury occurred from April 10 to May 20. The desirable time for planting corn at Manhattan is from April 20 to May 10. This fact suggests the impracticability of delaying planting in order to avoid wireworm attacks.

Continuous Corn and Rotation Plots.—Observations were made for a six-year period on the continuous corn area and the plots devoted to crop rotation systems. Each of the areas were made up of a series of plots treated with commercial fertilizers or manures, but the counts for the individual plots are not included in the discussion. The records of injury on the continuous corn series and the various rotations are taken on each series as a whole.

In 1924, only the hills were counted; hence, the percentage of plants attacked would undoubtedly be lower than the seven-tenths per cent given in Table 4. For the six-year period, the greatest amount of injury occurred in 1929, when a count of ten rows, extending crosswise of the plots, totalling 3215 plants, showed an injury of 77 plants, or 2.09 per cent. The years 1925 to 1928, inclusive, showed a very low percentage of infestation.

A brief survey of Table 4 indicates clearly that corn grown on land cropped to continuous corn suffered less from wireworm damage than that grown in rotations with wheat and oats, because, in the former case, the land is kept free of other grasses and weeds except what comes up in the field after the cultivation season. The average percentage of injury to corn grown in the cowpeas after wheat rotation amounted to .74 per cent; corn, oats, alfalfa, and sorghum rotation, .75 per cent; 16-year rotation, .52 per cent as compared with .45 per cent to the continuous corn for the same period.

Since it is generally believed that click beetles select grasslands in which to deposit their eggs, the introduction of a small grain crop into the rotation increases the possibility of an infestation, provided other environmental factors are suitable to the life processes of the insect. Plots sown to wheat and oats usually become grassy after the crop is harvested and before the seed-bed is plowed in preparation for the next crop. This delay affords an opportunity for the females to deposit their eggs. The data in Table 4 also show very little difference between the amount of injury occurring on the various rotation systems.

Frequently, crop rotations are recommended as a method of control for wireworms. The writer believes that the data submitted in Table 4

TABLE 4. WIREWORM INJURY TO CORN WHEN GROWN CONTINUOUSLY AND IN ROTATIONS

	1924			1925			1926			1927			1928			1929			Per cent of Injured Plants for Six-year Period
	Total Plants	Injured Plants	Per cent Injured	Total Plants	Injured Plants	Per cent Injured	Total Plants	Injured Plants	Per cent Injured	Total Plants	Injured Plants	Per cent Injured	Total Plants	Injured Plants	Per cent Injured	Total Plants	Injured Plants	Per cent Injured	
Continuous corn.. ..	5849	45	.7	12580	23	.18	17728	69	.38	14545	45	.31	16161	29	.18	3215	77	2.09	.46
Corn, wheat, cowpeas.	6772	38	.5	10825	35	.30	No record			No record			7352	9	.12	1229	34	2.76	.74
Corn, oats, alfalfa, sorghums.. ..	1861	14	.7	3061	17	.55	4925	39	.70	5088	51	1.00	4423	14	.34	1964	25	1.27	.75
16-year rotation, corn after wheat	5350	70	1.3	10501	31	.29	No record			14389	69	.47	No record			6277	5	.08	.52

indicate that the crops included, as well as the sequence in which one crop follows another, are important factors to be considered.

Correspondence which came to the writer's attention in this study included a report by a farmer in which he stated that wireworms attacked corn planted on land previously cropped to alfalfa for a number of years. The severest infestations occurred in low areas which had become grassy after the alfalfa had died. This report also suggests that wireworm infestations are likely to occur even though alfalfa is included in the rotation, if the sod has been allowed to become grassy before the land is plowed.

Observations were also made of wireworm injury to rye sown on land previously cropped to Sudan grass used as a pasture crop. The species involved in this instance was *Drasterius elegans* which requires but one year in which to complete its life cycle. The field had been used as a small pasture for a period of years previous to 1924, when the infestation occurred. The larvae of this click beetle were found in about equal numbers with the larvae of the southern corn root worm, *Diabrotica duodecimpunctata*. Approximately one-half of the plants on the area were injured or destroyed. There is no question but what the female click beetles had laid eggs in the Sudan grass pasture the preceding year.

TILLAGE INVESTIGATIONS AND WIREWORM INJURY.—A preliminary study was made of 15 one-tenth acre plots, rotated in blocks of five with wheat and oats, each one year. The plots were plowed as follows: Plowed 10–12 inches deep, July 15; seven inches, July 15; three inches, July 15; seven inches, August 15; and three inches, September 15, in the preparation of the seed-bed for wheat. The wheat stubble was fall plowed in preparation of the land for corn, while the oats were sown on disked corn stubble.

No counts were made for the year 1925, while only the percentage of injury is given for 1929. Every hill was dug out of the five plots in 1929, and 2700 wireworms taken, 1000 of which were found in the plot, plowed three inches deep in September. Table 5 shows the data taken from 1926 to 1929, inclusive, on corn grown under the different tillage practices.

An examination of Table 5 shows that severe wireworm injury occurred on the five plots of the series planted to corn in 1929. The heaviest infestation was found on those plots plowed August 15, seven inches deep; and September 15, three inches deep, over the four-year period.

This study indicates that late plowing in the preparation of the seed-bed for wheat furnishes favorable conditions for female click beetles to

TABLE 5. PERCENTAGE OF INJURY TO CORN GROWN UNDER DIFFERENT TILLAGE PRACTICES

Preparation of Seed-bed for Wheat	1926 Total Plants	1926 Injured Plants	1926 Per cent Injured	1927 Total Plants	1927 Injured Plants	1927 Per cent Injured	1928 Total Plants	1928 Injured Plants	1928 Per cent Injured	1929 Total Plants	1929 Injured Plants	1929 Per cent Injured	Per cent of Injured Plants for 4-Year Period
Plowed July 15, 10–12 inches				1368	7	.51	1063	0	0	——	–	15	5.17
Plowed July 15, 7 inches. . .	981	46	4.7	1119	13	1.16	1124	0	0	——	–	20	6.46
Plowed July 15, 3 inches. . . .	904	83	9.1	1089	21	1.93	1061	4	.38	——	–	25	9.10
Plowed Aug. 15, 7 inches. . . .	1111	46	4.1	1111	29	2.61	1117	2	.18	——	–	75	20.47
Plowed Sept. 15, 3 inches. . . .	1033	62	6.0	1086	16	1.47	1082	5	.46	——	–	99	26.73

deposit their eggs because the wheat stubble land becomes grassy and suitable for oviposition. Apparently the depth to which the land was plowed made very little difference upon the amount of injury found.

Further observations and rearing work will be necessary to determine the effect of various tillage practices upon the wireworm infestations. However, it is the opinion of the writer that tillage practices undoubtedly account for some of the wireworm infestations occurring in cultivated crops.

Summary

1. A six-year study of wireworm injury to Indian corn planted on land subjected to various farming practices conducted at this station shows that the severity of wireworm infestations is influenced by the various methods.

2. A perceptible increase in the percentage of wireworm injury was evident in the rate of planting studies when the plants were spaced 20 inches or more apart. This fact also held true for the rate and date of planting tests started in 1929, the injury being greater to corn planted on May 2 than that planted on May 18.

3. The date and method of planting plots showed a greater injury to corn planted from March 31 to May 10 at Manhattan, than that planted later. Listed corn suffered the least from wireworm injury while that planted in the open furrow and on the surface exhibited the greatest injury. There was very little difference between the percentage of injury shown between the corn planted on the surface and that in the open furrow.

4. Observations on crop rotation systems indicate that those including wheat, oats and alfalfa are conducive to wireworm infestations if the land is allowed to become grassy before preparing the seed-bed for the next year's crop. Corn planted on land cropped continuously to corn for a period of years showed less injury than that grown in rotations.

5. The time of plowing wheat and oats stubble in preparation for the following crops influenced the amount of wireworm injury occurring in corn planted on these plots. Stubble land, plowed September 15, had a greater infestation than that plowed immediately after harvest.

Literature Cited

Miles, Herbert W. and Petherbridge, F. R. Investigations on the Control of Wireworms. Ann. Appl. Biol., 14:359–387.

PRESIDENT T. J. HEADLEE: We will now listen to a paper by Leonard Haseman.

THE HESSIAN FLY LARVA AND ITS METHOD OF TAKING FOOD

By LEONARD HASEMAN, *Columbia, Mo.*

ABSTRACT

The larva of the Hessian fly (*Phytophaga destructor* Say) has a perfect digestive tract similar to other fly larvae. It takes only liquid food and its mouth organs seem well fitted for taking food from the plant tissues. The oesophagus is very slender, the proventriculus well developed, joining the very large ventriculus with a typical oesophageal valve. The paired salivary glands consist of an enlarged basal part and a cylindrical distal portion. The single pair of well developed Malpighian vessels connect with the ilium immediately behind the ventriculus. The posterior portion of the ilium is much constricted and joins the expanded colon with a perfect valve. The larva appears to be well equipped physically to take food from the host wheat plants and a study of its digestive tract fails to explain why it is able to mature more successfully on one strain of wheat than on another.

To those of us who are especially interested in Hessian fly investigations and particularly to those working on the relative susceptibility of the different strains of wheat to fly infestation, the question of just how the fly maggot takes its food is of special interest. For several years the writer has been interested in undertaking a careful study of the anatomy and physiology of the fly larva, but not until recently was the opportunity offered to undertake the work. These brief remarks will deal entirely with the digestive tract of the larva. At a later date a more detailed report on its anatomy and physiology will be prepared. In this study it has been necessary to use living larvae; mounted specimens of dissected larvae, and stained microtome sections.[1]

With all that has been said and written regarding the Hessian fly it seems strange that apparently so little information on the anatomy and physiology of its larva is available. Dr. Marchal's exhaustive report, on the Cecidomyidae attacking cereals, in the Annals of the Entomological Society of France for 1897 included a somewhat detailed anatomical study of the Hessian fly larva. C. C. Hill's report on *Platygaster vernalis* Myers, an important parasite of the Hessian fly, in the Journal of Agricultural Research for 1923 also included some figures on the anatomy of the larva. The anatomy of a related species, *Cecidomyia resinicoloides*, was carefully worked out by Francis X. Williams

[1]The writer is greatly indebted to C. C. Hill of the Bureau of Entomology for the loan of the slides of microtome sections prepared by him in his parasite study.

and published in the Annals of the Entomological Society of America in 1910.

HEAD AND MOUTH.—The head of the larva, while small and retracted, is surrounded by a rather rigid ring of brown chitin, which interferes with sectioning. The mouth is literally filled with what appear to be two pairs of brown chitinous structures and a rather distinct forked structure, probably the labium. The large outer curved pair extend dorso-caudad as slender brown prongs. Fitting into the curved mesal surface of these is the second smaller pair of chitinous structures. Between these is an oval opening through which the plant sap is probably drawn. The surfaces of these paired structures are rough, or toothed, and they are undoubtedly made use of in taking sap. Dorso laterad to the mouth are the short, but distinct, antennae.

In the floor of the mouth the common duct of the large paired salivary glands opens. The epithelial lining in the back part of the mouth, or pharynx, consists of rather large deep-staining cells. Surrounding the pharynx and extending back halfway to the brain is a girdle of tissue, which stains deeply and which can easily be seen in the living larvae. Near the caudal end of this girdle appear two distinct oval pigment spots. It is possible that this girdle of tissue about the pharynx may function in helping to draw the plant sap into the digestive tract.

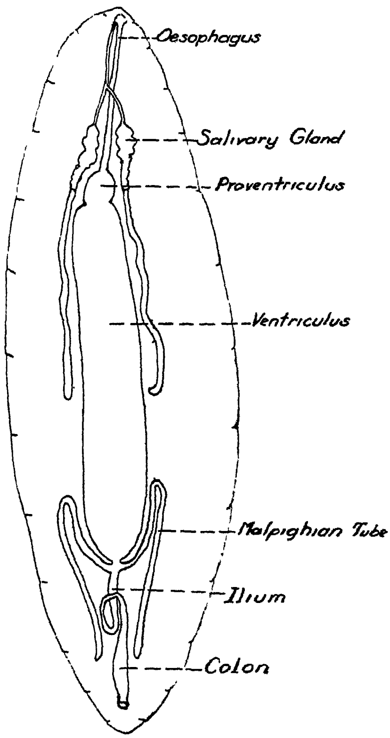


FIG. 36.—Diagram of alimentary tract of Hessian fly larva.

OESOPHAGUS.—The oesophagus extends caudad as a very slender tube through the brain to join the prominent proventriculus located in the fourth body segment. The epithelial cells of the oesophagus are very small and the lumen is much constricted. In cross section the oesophagus is scarcely noticeable with its lumen practically closed.

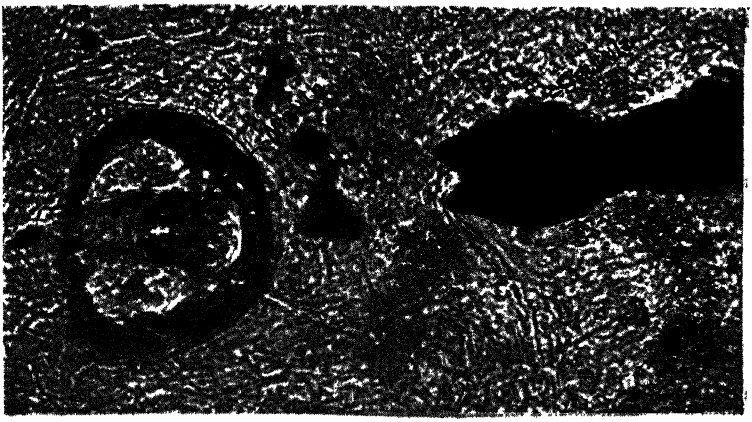
SALIVARY GLANDS.—The paired salivary glands each consists of an enlarged basal portion and a cylindrical distal portion. The common duct to the glands extends from the mouth back to a point about halfway to the brain, where it divides, a duct going to either gland. The enlarged basal portions of each gland extend from the region of the brain back to the proventriculus where the distal long cylindrical portion begins. The distal portion fits into a concavity on the caudal edge of the enlarged basal portion. The distal portion extends caudad along the side of the ventriculus to the middle of the seventh body segment. The cells of the basal portion are very large, giving to its surface an escalloped appearance. The cells of the posterior portion are smaller but with large nuclei. The lumen in this portion of the gland is distinct.

PROVENTRICULUS.—The proventriculus is slightly oblong in shape, its diameter nearly one-half that of the ventriculus. Its connection with the ventriculus forms a typical valve projecting into the ventriculus. Its epithelial cells are large with conspicuous nuclei.

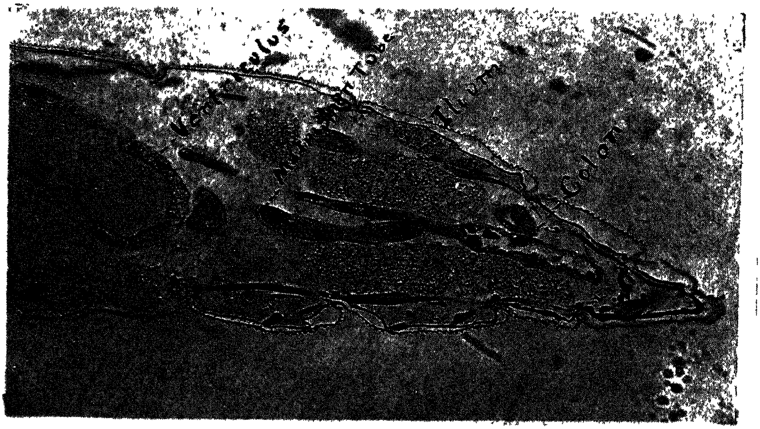
VENTRICULUS.—The most conspicuous thing about the ventriculus is its enormous size and its giant epithelial cells with their large nuclei. These cells and nuclei are so large that they can easily be seen in the living specimens, even with the low power of a compound microscope. Looking down on the surface of the ventriculus the enormous cells appear in rows. The ventriculus extends from the middle of the fourth body segment to the caudal edge of the ninth. It is cylindrical, usually stuffed with food, including a very fine green granulation, and fills practically all the space between the two lateral rows of fat-bodies. Its diameter is approximately one-eighth its length. In living specimens peristaltic action is going on practically all the time.

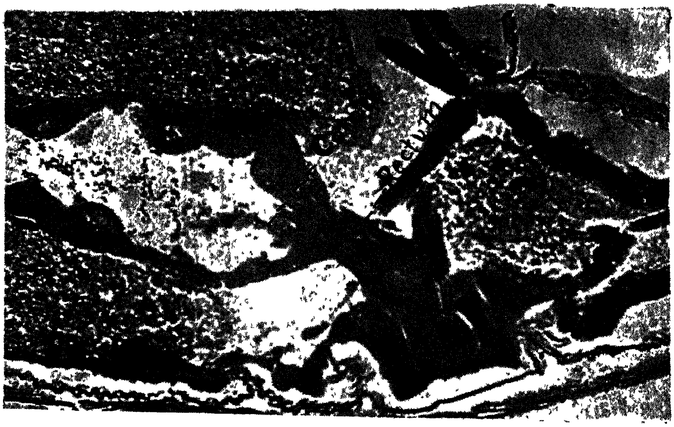
MALPIGHIAN VESSELS.—There is a single pair of Malpighian vessels. They connect with the ilium immediately caudad to the ventriculus. The connection is so close that they almost appear to connect with the ventriculus. They connect on the lateral surface of the ilium and each bends forward along the side of the ventriculus to a point near the middle of the eighth body segment when they turn caudad and extend back to near the middle of the colon. Their cells are large and have a brownish pigment.

ILIUM.—Where the ilium joins the ventriculus its diameter is approximately the same as that of each Malpighian vessel. The enlarged basal portion of the ilium extends back almost to the cephalic end of the enlarged colon where it turns abruptly cephalad to a point almost halfway back to the ventriculus. Here it abruptly constricts to a narrow



Hessian fly larvae anatomy shown in microtome sections.





Hessian fly larvae anatomy shown in microtome sections.

tube of about the same diameter as the oesophagus. This slender portion then turns caudad and joins the colon in the tenth body segment. The cells of the enlarged portion of the ilium resemble those of the Malpighian tubes so much that for a time sections across it were mistaken for sections of the Malpighian tubes. The epithelial cells of the slender portion are very small and their nuclei are inconspicuous. The ilium of the young larvae does not show such a marked looping. In some specimens the looping may extend back to the caudal end of the ventriculus.

The ilium, like the proventriculus, joins the colon with a distinct valve extending into the colon.

Colon.—The epithelium of the expanded colon consists of large cells with prominent nuclei. The diameter of the colon is twice that of the Malpighian tubes. It extends from its union with the ilium in the tenth body segment to the short and much constricted rectum.

The epithelial cells of the rectum are smaller than those of the colon. The anus opens on the twelfth body segment through a rather inconspicuous slit.

The larva of the Hessian fly has, therefore, a normal digestive tract closely resembling that described for other dipterous larvae. Being a feeder on sap, its mouth and oesophagus are constricted though its ventriculus is greatly expanded. Lying as it does, between the base of a leaf sheath and the stem of the wheat plant, it is in position to firmly attach its mouth with its chitinous mouth organs to the surface layer of plant cells and from them extract its food. The depression in the stem of the plant in which the fulfed larva or flaxseed is found imbedded indicates that in taking its food it eventually destroys the plant cells where it feeds. With every indication that the feeding larva is fully equipped to take plant sap from the surrounding plant cells, it would seem that ease or difficulty of the larva in taking food, once it reaches its normal feeding grounds, could not account for the susceptibility or the comparative resistance of the different strains of wheat to Hessian fly attack. The ability of the fly to mature better in one strain of wheat than in another must be due to factors other than the actual physical labor of taking food from the surrounding plant cells.

Mr. E. P. Felt: May I ask the speaker whether his study led him to conclude that the mouth parts of this larva are used to abrade the tissues; furthermore, whether he has observed the function of the breastbone. Is that used in the abrading of the tissues?

Mr. L. Haseman: I feel rather certain that the mouth organs are used in some way in helping to get the sap from the cells. We know, of

course, that the larvae take sap, get it by some means or other, and I feel certain that this elaborate type of structure in the mouth must be used in some way in making this possible.

I haven't given any considerable thought to the "breast bone." I doubt, however, if it is used for that purpose as I find that it becomes very much more prominent after the flaxseed case is formed.

Mr. E. P. Felt: I should like to supplement the question by calling attention to the fact that in some species, at least, the breast bone is evidently used as a graving tool, especially in species which live in soft wood. I have seen in the case of one which develops in the pine, the breast bone actually used as a tool in digging out considerable quantities of wood powder. This is also true of the larvae in the pith of certain herbaceous plants.

Mr. L. Haseman: I might say that Dr. Marchal and other workers have concluded that the "breast bone" or "sternal spatula" of the Hessian fly larva is used in reversing the position of the larva in the flaxseed case. I have made no careful study of this structure as yet.

I have in the course of preparation sections of the wheat plant in the region of feeding, which will probably help me in determining to what extent, if any, the tissues are rasped by either the breast bone, if it is used for that purpose, or by the mouth organs.

Mr. R. H. Painter: At the Kansas Agricultural Experiment Station we have been interested in the problem of the resistance of wheat varieties to attack by the Hessian fly, and in the last two or three years I have attempted to study this problem of the feeding of the larva because that is one of the main points in regard to the resistance of the wheat varieties.

In Marchal's paper of 1897, I found a good discussion of the internal anatomy of this insect. Although he is rather vague in some places in regard to the structure of the head, I may say, as Doctor Haseman has pointed out, this part is very small. In fact, you can get most of it at one time under the high power oil immersion. There are some discrepancies between Doctor Haseman's account and that given by Marchal. I am just wondering if this may not be concerned in an explanation of some of the facts which I will bring out in my paper this morning; that is to say, the presence of different strains of Hessian fly.

I have been studying the larva in situ in the plant tissue by means of sections. Probably a good many of you realize that it is a difficult thing to section both plant and animal tissue at the same time.

Perhaps I can answer the questions which Doctor Felt raised in regard to the feeding. I have been unable to find any evidence of a tearing up of the plant cells by the larvae which I have studied. There is no hole in the wall of those cells large enough to be visible under the compound microscope.

The mid-gut of the larva contains only liquid matter. There is a question in my mind as to whether the mouthparts are heavy enough or capable of piercing the cell walls of the plant. It is quite possible that they may have some influence in mechanically irritating the plant tissue. The best evidence we have concerning effect on the plant is that cells inside the plant and four or five cells away from the larvae are injured. It is probable that secretions from the insect pass to those cells, which are far beyond the reach of the mouthparts.

Frankly, the problem of feeding of the Hessian fly appears to be a matter of the permeability of the cell wall, especially at the time the larva starts feeding, and in regard to the cells at a distance from the larva.

According to Marchal's paper, and some observations I have made in this matter, the "breast bone" is not present in the feeding larvae of the Hessian fly. I should like to know whether some of the other workers have located the "breast bone" in this stage. It is present in the larva which is enclosed in the flaxseed, where, according to Marchal, it is used in reversing the position of the larva.

Vice-President F. N. Wallace assumed the Chair.

A Wild Host of *Mineola scitulella*. A moth, *Mineola scitulella* Hulst, which Mr. Wakeland reports as doing considerable damage to apricot and prune fruits in a few parts of southern Idaho, was reared from chokecherry galls in southern Cache County during the summer of 1929. The galls caused by an ascomycete, *Plowrightia morbosa*, were very numerous on the branches and stems of the chokecherry, *Prunus melanocarpa*, in Sardine canyon and were almost invariably infested with small lepidopterous larvae. On May 15 the galls were numerous and contained larvae of different sizes. Several galls were brought into the laboratory, and on June 28 one adult, *Mineola scitulella*, emerged. Larvae of varying sizes were present on July 10, at which time another collection was made. From this material two adults of *M. scitulella* and several adults of a smaller dark brown species emerged. *Mineola scitulella* was also reared from wild plum collected at Lewiston, in northern Cache County early in the summer of 1929. The U. S. National Museum has specimens of this moth from Colorado, New Mexico, Utah, Washington, Idaho, and California.

H. J. PACK and V. DOWDLE, *Utah Agricultural Experiment Station*

VICE-PRESIDENT F. N. WALLACE: We will now hear a paper by R. H. Painter.

THE BIOLOGICAL STRAINS OF HESSIAN FLY[1]

By REGINALD H. PAINTER, *Kansas State Agricultural College*[2]

ABSTRACT

Under field conditions, some of the wheat varieties attacked by Hessian fly (*Phytophaga destructor* Say) in the soft wheat belt of southeastern Kansas, show a degree of infestation different from the same varieties under infestation in the hard wheat belt of central and western Kansas. In the latter case, for instance, Kanred wheat is susceptible to fly, while Illini Chief selection 223415 carries very little or no infestation. At Columbus (southeastern) Kansas, these two varieties were about equally susceptible. In the field, some wheat varieties are resistant in both places.

Under uniform greenhouse conditions, fly from the two regions gave infestations approximating the respective field results on these and other varieties. Fly from Ohio and Indiana gave infestations differing from those of the two Kansas sources and from each other.

Under greenhouse conditions, infestation by fly from the hard wheat belt of wheat varieties planted on a wide range of separate soil types, did not give infestation percentages varying greatly from normal for fly from this source.

Strains of fly with different infestation capacities may be selected from central Kansas fly by use of individual pairs and by mass selection. In the former case, strains have been carried through three generations without change in their infestation abilities.

It is concluded that these differences in fly population are not due primarily to ecological conditions. The data tend to show that the Hessian fly population of any one locality consists of a mixture of two or more genetically distinct strains which differ in their ability to infest various wheat varieties.

Observations in the past by a number of investigators[3] on the resistance of wheat varieties to Hessian fly attack, do not agree in all respects

[1]Contribution No. 381 from the Department of Entomology. This paper embodies some of the results obtained in the prosecution of Purnell project No. 164, the Departments of Entomology and Agronomy cooperating.

[2]Acknowledgments: I am indebted to Prof. S. C. Salmon, Dr. John H. Parker, Dr. M. C. Sewell, and Mr. I. K. Landon of the Department of Agronomy, for help on the agronomic phases of this problem, especially in respect to care of the seed, of varietal selections, and in the soil study. I am also indebted to my colleagues in the Department of Entomology, especially Prof. Geo. A. Dean and the late Prof. J. W. McColloch for many helpful suggestions. I also wish to thank Mr. C. M. Packard and Mr. R. A. Blanchard of the United States Bureau of Entomology, for collecting and sending "flaxseed" for use in some of the experiments.

[3]Discussion of literature in:

McColloch, J. W. and Salmon, S. C. Relations of kinds and varieties of grain to Hessian fly injury. Jour. Agri. Res. 12:519–527. 1918.

Packard, C. M. The Hessian fly in California. U.S.D.A. Tech. Bull. 81, 25 pp. 1928.

either as to varieties injured or in regard to amount of injury. Certain workers have even found no evidence of resistance. However, later investigators, especially in Kansas and in California, have shown quite conclusively that differences do exist in the extent of fly infestation among wheat varieties as such experiments have been conducted.

Evidence is presented here that the presence of biological or physiological strains of the Hessian fly in various parts of the country may, in part at least, explain the differences obtained by various investigators and also some other discrepancies which have arisen in the course of fly studies at the Kansas Agricultural Experiment Station. Evidence is presented along four lines, three of which are positive and one negative:

(1) FIELD OBSERVATIONS AND INFESTATION COUNTS.—In Kansas, there are two chief wheat-growing regions, an eastern soft wheat belt and a central and western hard wheat belt, separated by a rolling or even rugged pasture section known as the "Flint Hills," within which wheat is grown only in the narrow valleys. Practically all of the observations in Kansas on resistance to Hessian fly have been made in the hard wheat belt west of the Flint Hills. An extension of the research program by the Kansas stations led to the establishment in various parts of the state of uniform variety nurseries for the study of resistance to Hessian fly. The results of such studies from the nursery at Columbus, Kansas, in the southeastern corner of the state, have been distinctly at variance with previous tests in which the source of infestation was fly from central and western Kansas. A comparison of a few of the varieties is given in Table 1.

TABLE 1. FLY INFESTATION ON WHEAT VARIETIES IN DIFFERENT PARTS OF KANSAS

Variety	Selection Number, etc.	% of Tillers[1] Infested: Fly Nursery Manhattan, Ks. Nov., 1927	Columbus, Ks. Dec., 1928	Columbus, Ks. May, 1929
Illini Chief Sel.......	223415	1.37	12.6	34.9
Kanred............	K2401	35.3	13.3	51.9
Dawson............	K2564	0.0	16.8	38.5
Kawvale.........	K2593	0.0	4.0	6.7
Blackhull...........	K343	10.2	3.6	5.1

[1]The term "tiller" is applied to all branches of the wheat plant, including the first sprout. In the spring count there are included under this term, both the jointed culms and the unjointed non-fertile branches.

The 1927 infestation in the fly nursery at Manhattan may be taken as characteristic of a large number of tests which have been conducted, in which fly from western Kansas was used. It will be seen that the infestation from Columbus fly is radically different. In respect to

Dawson and Illini Chief Selection,[4] as compared to Kanred, there is almost a reversal. Since the varieties are the same, this difference must be due to ecological conditions, or to a difference in the character of the population of fly.

(2) Uniform Greenhouse Tests.—Uniform sets of seven varieties of wheat and one variety each of rye, emmer, and spelt were exposed separately to fly from Columbus (southeastern), Kansas; central Kansas; Carpenter, Ohio; and Indianapolis, Indiana. These sets of plants were exposed in cages side by side and as nearly simultaneously as the emergence of the fly permitted. The temperature and moisture conditions in the greenhouse were reasonably constant throughout the experiments. Soil conditions were the same for all plants. The experiment was repeated for the fly from all places except Indianapolis.

Table 2. Uniform Greenhouse Tests on Fly From Different Parts of Kansas and from Other States

Variety	Selection Number etc.	% of Tillers[1] Infested by Fly From Central Kansas	Columbus, (Southeastern) Kansas	Carpenter, Ohio	Indianapolis, Indiana
Illini Chief Sel......	233415	0	100	75.6	45.6
Kanred.	K2401	20.9	60	43.0	43.3
Kawvale	K2593	0	72.7	4.7	17.7
Blackhull.........	K343	14.8	70	22.2	30.1
Winter Rye..... ..		0	18	12.5	5.5
White Spring Emmer		0	90	0	10.0

[1]The term "tiller" is applied to all branches of the wheat plant, including the first sprout. In the spring count there are included under this term, both the jointed culms and the unjointed non-fertile branches.

Under these conditions, the fly from southeastern and from central Kansas gave infestations closely paralleling the results obtained in the field. The fly from Ohio and Indiana gave results differing from each other and from the two Kansas sources.

(3) Soil Tests.—Kanred and Tenmarq, which are susceptible to infestation by fly from central Kansas and an Illini Chief selection and Kawvale, which are resistant, were planted in pots in five kinds of soil. These included a soil deficient in silicon and calcium from southeastern Kansas, a dune sand, a heavy clay, a well manured soil, and a soil to which phosphate and lime had been added. Thus this experiment included a wide range of soils. After the plants had tillered, they were infested with fly from central Kansas. The infestation of the wheat

[4]In all places in this paper where Illini Chief is mentioned, reference is made only to selection 223415 made by the Agronomy Department. This is a head row selection from the variety. The complete history of it is to be found in records of the Agronomy Department.

varieties grown on the various soils showed some small differences, but nothing approaching the reversal of infestation which was found in the comparison of the southeastern and central Kansas fly.

(4) Selective Breeding of Strains of Hessian Fly.—Individual pairs were chosen from fly from central Kansas. After mating, the females were allowed to oviposit on plants of Kanred wheat, which is susceptible to this fly, and on a selection of Illini Chief, which is resistant. From these pairs it was possible to select a number of races with ability to infest Kanred, but not Illini Chief; and a few with ability to infest both of these varieties about equally. These strains, which differ in infestation capacity, have been carried through three generations without a change in this characteristic reaction.

In approaching the problem from another angle, an attempt was made to build up an infestation on Illini Chief by a kind of mass selection. In several experiments it was found that the few "flaxseed" which developed on Illini Chief from infestations of central Kansas fly always gave about equal infestation on Kanred and Illini Chief. In other words, it is possible to select, from the normal fly population of the hard wheat belt, a group of individuals which have a different infestation ability from that population. On the other hand, fly which developed on Kanred have always given a heavy infestation on Kanred and a very small or no infestation on Illini Chief, in succeeding generations.

Observations of infestations on cooperative variety tests conducted by the Agronomy Department in various parts of the state appear to indicate that in general the soft wheats frequently are more or less resistant in the hard wheat belt, while in the soft wheat belt the varieties which are resistant are more frequently the hard wheats. These field observations give some indication that we may expect varieties to be most heavily infested where they are grown in greatest abundance.

Discussion and Conclusion.—The data presented here may be interpreted as indicating that the Hessian fly population of any one locality consists of a mixture of two or more strains, which differ in their ability to infest different varieties of wheat. Preliminary data from breeding experiments with these strains of fly, and extensive field and greenhouse experiments on infestation of pure lines of wheat, indicate that these biological or physiological strains of fly are genetically distinct. In at least one case, strains of fly have been selected from the Hessian fly population of central Kansas, which will infest the varieties Kanred and Illini Chief in a differential manner. It appears probable that such selections have arisen in nature.

With respect to the use of resistant varieties, two courses are open. We may develop resistant varieties which may be used alternately for periods of years in a given region, or we may attempt to synthesize the resistant qualities of several wheat varieties through hybridization and selection. In this connection it may be noted that under natural field conditions in both central and southern Kansas, certain varieties show resistance to more than one strain of fly. Thus Kawvale shows considerable resistance to fly from both eastern and central Kansas, and Blackhull is less susceptible than Kanred to fly from both the hard and soft wheat sections.

VICE-PRESIDENT F. N. WALLACE: The next paper is also by R. H. Painter.

OBSERVATIONS ON THE BIOLOGY OF THE HESSIAN FLY[1]

By REGINALD H. PAINTER, *Kansas State Agricultural College*

ABSTRACT

By following the individual histories of eggs of Hessian fly (*Phytophaga destructor* Say) laid on different leaves, it is shown that no flaxseed survive from eggs laid on the outer (1st leaf); 6.35 per cent survive from eggs laid on the 2nd leaf; and 45.4 percent survive from those on the 3rd (central)leaf. This decrease in survival on the different leaves is paralleled by the increase in deposition of cellulose or perhaps with some condition arising with it. These facts are of interest in connection with the resistance of certain cereals to the attack of Hessian fly.

The progeny from isolated single pairs of fly were predominately of one sex. Out of 13 matings, four gave all males; five all females, and four with offspring predominately of one sex. In one case, 74 females and no males were reared from one pair.

SURVIVAL OF HESSIAN FLY FROM EGGS LAID ON VARIOUS LEAVES OF WHEAT.—In connection with the detailed studies of Hessian fly during the isolation of biological strains, certain life history observations were made which do not seem to have been reported in the literature. The numbers of flaxseed resulting from eggs laid on different leaves of the plant have been recorded with the results given in Table 1.

TABLE 1. SURVIVAL OF HESSIAN FLY FROM EGGS LAID ON VARIOUS LEAVES OF WHEAT

	On Leaves of Kanred			On All Leaves
	1st Leaf	2nd Leaf	3rd Leaf Central	of All Varieties Total
Number of Eggs	45	73	271	2017
Number of Flaxseed	0	5	123	376
Per cent Survival	0	6.35	45.4	19.8

[1]Contribution No. 380 from the Department of Entomology. This paper embodies some of the results obtained in the prosecution of Purnell project No. 164, the Departments of Entomology and Agronomy cooperating.

The Hessian fly females were allowed to oviposit on a certain number of wheat plants possessing only three leaves. The positions of the eggs were recorded. After the formation of flaxseed, the plants were carefully dissected to determine the location of these puparia with respect to the different leaf sheaths. The first three columns in Table 1 give the results for Hessian fly from the hard wheat belt of Kansas on Kanred wheat. The fourth column gives the total eggs and flaxseed for several strains of fly and the several varieties of wheat studied in this problem. Results have been used only in those cases where some flaxseed were formed on the plant under observation. A comparison of the percentage of survival of eggs laid on the third leaf with the total survival of all flies studied shows that there is a mortality of about 25% due to the position of the eggs on the plant.

The marked decrease in percentage survival from the central leaf outward is paralleled by the increase in deposition of cellulose[2] in the cell walls of the wheat crown where the larvae must begin feeding. The inability to commence feeding on the outer leaves, hence, may be due to the presence of cellulose or to some condition arising with it. With

TABLE 2. SEX OF HESSIAN FLY FROM SINGLE PAIRS

Mating Number	Number Flaxseed	Emergence Male	Emergence Female
17	20	16	0
20	42	13	2
37	47	1	34
38	104*	42	6
40	21	0	9
42	20	14	0
45	20	10	3
46	39	0	18
57	88*	36	0
59	134†	0	74
67	60*	0	20
70	53	0	29
R8	32	16	0
Totals		148	195

*Many small not viable.
†39 flaxseed were very small.

some wheat varieties, this fact is of no importance in most resistance studies, as the resistant varieties, when infested, show data paralleling that given for Kanred. In the case of some other varieties, such as

[2]Cellulose was identified by means of polarized light. In the meristem tissue, especially of the epidermis, only two cell wall substances have been shown to be present in most cases. The pectic materials of the primary cell wall show dark under polarized light, the cellulose material appears bright. Other tests are being used as a check in future work, but in this particular tissue, polarized light is most useful for a preliminary study.

Blackhull and Red Winter (Kansas 2132) which give a medium infestation, an early development of cellulose may be of considerable importance, It may be a factor in the spring generation of fly on early maturing wheat varieties and in accounting for the noninfestation of some of the other cereals, such as oats.

SEX RATIOS.—In attempting to secure a strain of Hessian fly from a single pair with known food habits and infestation capacity, an unexpected difficulty was encountered. The progeny of each single pair consisted predominantly or entirely of a single sex. The sex of progeny from some of the pairs is given in Table 2.

A number of other matings in which fewer than ten adults emerged gave similar results. It will be noticed that nine out of the thirteen matings gave either males or females, but not both. In none of the others is there an approach to the normal 1:1 sex ratio of other animals or to the 40–60 female ratio of the total and of the general run of material collected in the field and bred in the laboratory.[3] The result is not due to a possible differential death rate between the sexes as in two experiments conducted side by side, one will give all females, the other all males. It is not due to hybridity between biological strains because some of the data come from strains inbred for two or three generations of flies from one locality. In the related genus *Oligarces*, male-producing and female-producing strains have been demonstrated.[4] In the case cited, parthenogenesis with its attendant cytological modifications is involved while in the Hessian fly this abnormal development has not been demonstrated by previous workers and does not appear in my own experiments. The sex ratio here is similar to that studied by Metz[5] in Sciara where he finds that females may be male-producing or female-producing, but not both, and that there is probably a selective elimination of sperm in the female.

In economic entomology, these facts must be taken into consideration in breeding work. Moreover, on account of the production of progeny of a single sex, the migration of single females is of reduced importance.

[3]McColloch, J. W. The Hessian fly in Kansas. Kansas Agricultural Experiment Station. Tech. Bul. 11, p. 38. 1923.

[4]Harris, R. G. Sex of Adult Cecidomyidae (Oligarces sp.) arising from larvae produced by paedogenesis. Psyche 31:148–154.

[5]Metz, Charles W. 1929. Evidence that "Unisexual" progenies in Sciara are due to selective elimination of gametes (sperms). The American Naturalist 63:214–228. Other references to his previous paper are given in the bibliography.

VICE-PRESIDENT F. N. WALLACE: We will now pass to a paper by G. I. Reeves.

TRANSPORTATION OF THE ALFALFA WEEVIL BY RAILWAY CARS

By GEO. I. REEVES, *U. S. Bureau of Entomology*

ABSTRACT

Recent study of the occurrence of the alfalfa weevil *Phytonomus posticus*, in alfalfa meal and meal mills, as well as of its travel in freight cars, loaded and empty, casts grave doubt upon the efficacy of certain well-established methods of preventing the spread of the species. This investigation also suggests that measures designed to prevent the spread of pests ought to be tested by the same rigid scientific standards as are applied to field control methods, but with a technique adapted to the detection of vanishingly small numbers.

Although the alfalfa weevil has been present in the United States certainly since 1905, and probably much longer, there has hitherto been no body of facts available as to the methods by which it travels from place to place and invades new territory. There have indeed been scattered observations upon its occurrence on passenger trains and automobiles, as well as in various farm products, but the principal quantitative studies of its abundance have been of an order more suitable for use in field control than in the prevention of its spread.

The abundance and the persistence of weevils in alfalfa hay, at alfalfa-meal mills and in railroad cars have recently been minutely studied with a view to the detection of such small numbers of the insects as would be negligible in ordinary dealings with crop pests, although they might be decidedly significant as a feature of the dissemination of the species. Thus, the weevil population in a field may be of the order of 87 millions per acre, and the poisoning of five-sixths of that number may ensure fairly complete protection of the crop, under which circumstances a weevil population of 14 millions per acre might be considered economically insignificant. A much lower infestation might be serious in other species and upon other host plants. This would still, however, greatly exceed the numbers which must be guarded against in an effort to keep the pest out of uninfested territory. The study of the occurrence of the alfalfa weevil in alfalfa meal, meal mills and freight cars was accordingly planned to determine the number of weevils present in the square inch of ground or floor space and in the cubic inch of chaff and alfalfa meal, rather than the number to the acre of alfalfa.

Examination of Mills.—Every step in the cutting, handling, stacking, hauling, and milling of the three annual cuttings of hay, as well as of an additional preliminary cutting, was observed with reference to its eliminating effect upon the weevils. One mill was kept under observation throughout October, 1928, when the whole summer's accumulation of weevils, if any accummulation occurred, was present, and during which month more than 900 tons of hay passed through the mill. At this time the weevils were active and the weather was warmer than during the oviposition period of the weevil at Salt Lake, Utah. Ninety-five thousand cubic inches of hay, meal and litter, together with 126,640 square feet of floor, ground, wall and machine surface were examined. This consumed 140 hours of time.

Another mill was watched throughout June, August, September, November and December. The examination covered 79,627 cubic inches of material and 7,411 square feet of surface, and it required 155 hours.

Results Obtained.—In one of these mills were found 24, and in the other 20, living weevils, all in the receiving rooms and none of them in the finished product or the shipping-rooms of the mills. This record of finding one weevil to each 5.8 hours of search in the one mill and to each 7.75 hours in the other indicates the entire absence of the much-discussed tendency of weevils to accumulate at mills. Incidentally, it also establishes 6¾ hours as the minimum period for examination of mill premises to determine freedom from alfalfa weevils, even in the case of men of such extraordinary experience as those involved in this instance. No other examination of similar thoroughness has been recorded.

Since the weevils naturally present in hay upon its entrance to the grinder were so few as to make their recovery from the product impossible, 5,300 weevils were artificially added and the meal was searched bit by bit for their remains.

In addition to the field, haystack and mill survey which has been described, examinations were made of 130 cars from which hay had been unloaded. These contained, on the average, 34,872 cu. in. of chaff, of which 2,636 cu. in. were examined. One car in which all floor chaff was examined contained a total of 14,238 cu. in. of such chaff, in which were found 66 living weevils. The work required 9½ hours. These cars were then traced, with the assistance of railroad companies, for 60 days following their examination. Selected cars were also loaded with live alfalfa weevils and shipped across the weevil-infested territory, after which they were dismantled and thoroughly searched for weevils. The economic importance of this study, as suggested by the title, lies

almost entirely in the results of this car examination, the rest being merely the negation of most of the assumptions which have been made in attempts to prevent the spread of this insect. In technical interest, however, the car examination and history is merely an item in a somewhat unusual treatment of pest control.

These studies showed that relatively few of the weevils which are so abundantly present in the fields ever reach the stack, that those which do so perish for the most part before the hay is removed from the stack, that baling kills most of the remainder, and that a properly constructed and properly managed mill destroys the rest. Beyond that point, however, security ends. Cars which have been used for infested hay—and over 2,000 cars are so used each year—disperse rapidly into every corner of the United States. U. P. car 137680, in which one living weevil was found, moved empty into the Pacific Northwest in seven days and was in New York City on the 60th day after examination. U. P. car 10151, in which one weevil was found at the mill and two weevils two days later in the freight yards, reached Colton, California, 12 days after the initial examination. M. P. car 85485, in which 66 weevils were found, moved empty to Albany, Ore., not far from the new infestation at Medford, and arrived there within 17 days. In the light of experiments showing that 15 per cent of the weevils remain alive in the car during a five-day trip, and 40 per cent of them during a three-day trip, these car histories are ominous. It is believed that similar researches upon the means of travel of other insects might be equally productive.

VICE-PRESIDENT F. N. WALLACE: The next paper is by H. H. Knight.

"ALFALFA PLANT-BUG," A COMMON NAME FOR AN INTRODUCED EUROPEAN BUG (*ADELPHOCORIS LINEOLATUS* GOEZE) FOUND IN IOWA (HEMIPTERA, MIRIDAE)[1]

By HARRY H. KNIGHT, *Ames, Iowa*

ABSTRACT

The first specimens of an European plant bug (*Adelphocoris lineolatus*) found in the United States were taken at Ames, Iowa, June 18, 1929. It was previously known from North America only from Cape Breton Island. Extensive scouting shows that the bug was breeding over a limited area only with Ames and Des Moines near the center of distribution. It appears to be a clear case of accidental introduction within the past three or four years. In Iowa it has been found breeding only on alfalfa and sweet clover but in such numbers that it suggests the possibility of becoming a pest. The common name "Alfalfa plant-bug" is proposed for this insect.

[1]Contribution from the Department of Zoology and Entomology, Iowa State College, Ames.

While conducting a field trip with a class in general entomology, June 18, 1929, at Ames, Iowa, the writer took in his collecting net the first specimen of *Adelphocoris lineolatus* Goeze known from the United States. This species was previously known from North America, but only from Cape Breton Island when the writer recorded it in 1922 (Can. Ent., liii, p. 287). It was indeed a great surprise to look into my collecting net and see this large plant bug running about for the first time, and to realize that I was actually collecting in Iowa. Additional sweeping at the same spot netted only four more specimens. I thought the species must be scarce since considerable sweeping over the same area did not produce more specimens. This apparent scarcity was later explained after learning the host plants of the bug. There was only one sweet clover plant in the vicinity and this had doubtless produced all the specimens.

A few days later, June 30 to be exact, Mr. R. L. Preston, one of my students, took two specimens of *lineolatus* Goeze along a road just south of Ames. On July 2 we made a special trip to this point to search for the unusual Mirid. I soon began taking one or two specimens with each dozen sweeps of the net. Within half an hour I found that most of the adults and many nymphs were to be found on alfalfa and sweet clover which grew along the roadway. Further collecting has shown that *lineolatus* Goeze is breeding in large numbers on both these plants, and nymphs are rare if not absent on other plants. During July the bug was found in such numbers on alfalfa and sweet clover that it suggests the possibility of becoming a pest on these important plants. In some fields a dozen bugs could be taken on a single large plant; and in such places *lineolatus* Goeze was more abundant than the tarnished plant bug (*Lygus pratensis oblineatus* Say). In view of these facts the writer takes occasion to propose the common name "Alfalfa plant-bug" for *Adelphocoris lineolatus* Goeze.

In Europe *A. lineolatus* Goeze has been reported as found on *Chenopodium*, *Trifolium*, *Leguminosae*, *Umbelliferae*, *Eryngium*, *Carduus*, *Salvia*, *Euphorbia*, and *Calluna*. Fallen (1807) described our bug as new under the name *Lygaeus chenopodii*, indicating what he took to be the host plant. As yet we have not found it breeding on *Chenopodium* in Iowa.

The question of when and where *Adelphocoris lineolatus* Goeze was introduced into Iowa is a point which will become of more interest as time passes and the bug is found in adjoining states. Mr. R. L. Preston is making a survey of its distribution while working on the life history of the species and will report his results at some future time.

Just now it seems rather certain that the point of introduction was at Ames or Des Moines, with Ames more nearly the center of distribution as found by Mr. Preston. How long it has taken this insect to attain its present abundance and distribution is a question of interest to us. No specimens were taken in 1928, yet the writer and several students did fully as much collecting in this area that summer. During July many specimens of *lineolatus* were taken about electric lights on the campus; also we have found it very abundant in fields of alfalfa and sweet clover The species has certainly increased greatly in numbers since the summer of 1928, or we most certainly would have found it then. A guess is not worth much but I would suggest that the species must have gotten its start from three to five years ago. Mr. Preston has taken specimens over an area of about 75 miles from south to north with Ames about the center of distribution.

Should this insect develop into a pest on alfalfa as it gives some promise, it will become of wide interest and concern. In any case it represents the introduction and spread of an exotic species, and as a biological problem, will interest many students of entomology. No doubt the species was imported into Iowa in the egg stage which could easily happen if parts of the host plant were used as packing in some shipment of material from Europe. Just what materials have been shipped into our area is a matter we hope to investigate as opportunity permits.

It is hoped that this notice may stimulate collectors in the states bordering on Iowa and that some may sweep alfalfa and sweet clover during the next two or three years and report the occurrence and spread of *Adelphocoris lineolatus* Goeze.

As an aid for recognition of the species the following general description is given:

MALE. Length 8 mm., width 2.8 mm. General coloration pale yellowish with a tinge of brown and dusky; scutellum with two fine, longitudinal fuscous marks on middle, corium usually with a triangular fuscous area on apical half, cuneus pale, membrane fuscous. Antennae yellowish to brown, apical half darker and usually reddish brown. Legs yellowish, femora with many black dots, anterior aspect with two rows of somewhat larger spots; tibial spines black, without distinct spots at base. Clothed in simple, pale yellowish pubescence, but black on the legs.

Head: width 1.36 mm., vertex .42 mm. Antennae: segment I, length .98 mm.; II, 2.87 mm.; III, 2.2 mm.; IV, 1.3 mm. Pronotum: length 1.3 mm., width at base 2.25 mm.

FEMALE. Length 7.5 mm., width 2.9 mm. More robust than the male and usually somewhat paler in color, but otherwise very similar in form and coloration.

NYMPH, FIFTH INSTAR. Length 5.5 mm., width 2.4 mm. Head: width 1.17 mm., vertex .52 mm. Antennae: segment I, length .73 mm.; II, 2.3 mm.; III, 2 mm.;

IV, .85 mm. Color uniformly yellowish green, third and fourth antennal segments reddish brown, tips of wing pads becoming fuscous. Legs uniformly pale yellowish and marked with black spots as in the adult. Dorsum and legs set with short stiff black hairs; antennae clothed with black pubescence.

Size slightly larger than *Adelphocoris rapidus* Say, but easily distinguished by the paler color. The ge-ieral habits and actions of *lineolatus* Goeze are very similar to our native species, but it runs about in the net even more swiftly than *rapidus* Say.

PRESIDENT T. J. HEADLEE resumed the Chair.

PRESIDENT T. J. HEADLEE: The next paper is by J. H. Bigger.

NOTES ON THE LIFE HISTORY OF THE CLOVER ROOT CURCULIO, *SITONA HISPIDULA* FAB., IN CENTRAL ILLINOIS[1]

By J. H. BIGGER, *Illinois Natural History Survey*

ABSTRACT

The Clover Root Curculio, *Sitona hispidula* Fabr., is a potentially serious pest of clovers and alfalfa. Adults hibernate and oviposit both fall and spring. Eggs hatch in the spring. Larvae feed for 21–27 days on the nodules and small roots of the food plants. Pupation occurs mostly in June and requires 17–22 days. It is at approximately the time of first cutting of alfalfa for hay. Adults emerge during June and July and live practically an entire year.

The Clover Root Curculio, *Sitona hispidula* Fab.[2] has attracted very little attention up to the present time. During the course of a general study of clover insects in central Illinois it became apparent that this insect is a potential pest of clovers and alfalfa of considerable importance. These observations were made in 1923 and, as a result, during the fall of 1924 a study of its life history was started. Available time during the first season was occupied in developing a technic and becoming better acquainted with the insect. The most important records were obtained during the seasons of 1925–1926 and 1926–1927.

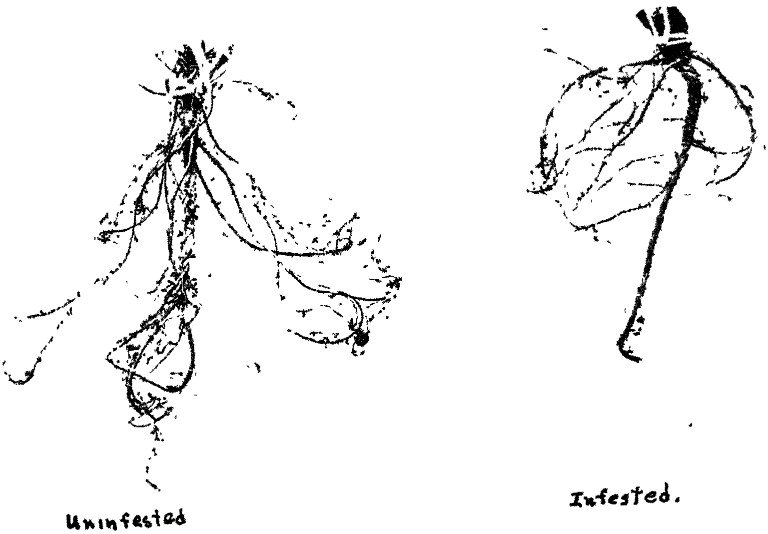
DAMAGE

The adults feed at the edges of the leaves, standing astride the edge and making typical rounded cuts in them. (Plate 14) Damage is usually not severe in this section, though we have one case on record

[1]Project 1.4 of the Entomological Section of the Illinois Natural History Survey.

[2]Identity checked by Dr. T. H. Frison and verified by Mr. C. A. Frost of Framingham, Mass. Mr. Frost wrote that specimens of this form had been submitted to Mr. Charles Drury, and determined by the latter as *S. hispidula*.

Feeding by adults of *Sitona hispidula* Fab. Each leaf fed on by one pair during 2-day period in November 1927.



Feeding by larvae of *Sitona hispidula* Fab. Right—Infested. Left—Uninfested. Dug June 10, 1927

where adults migrating from a recently plowed red clover field destroyed a half-acre of newly sown alfalfa in a few days. The migration was stopped or it is likely that the entire 10 acres in the alfalfa field would have been destroyed. In cages one pair have been known to consume a red clover leaf 30 mm. long and 15 mm. wide in four days. See also the report by Wiedermuth (4).

Larval feeding is the most serious part of the damage done to clover and alfalfa. It is all the more serious in that it is not seen in more than the minimum of cases, nor recognized when it is seen. The larval feeding (Plate 14) occurs first on the nodules, then the smaller roots, and finally on the main root system. In many cases roots have been dug where all the nodules and most of the smaller roots have been removed by this insect. They are frequently very numerous in the fields. One rather heavily infested field in Morgan county, Illinois, was examined May 18, 1927 and found to have 36, 43, 33, 41, 39, and 37 larvae respectively in square foot areas at different points in the field.

Descriptions

Adult. The adult of the Clover Root Curiculo, *Sitona hispidula* Fab., is a small weevil 3.5–5 mm. long. The pronotum is about 2 mm. wide at the middle and tapers both ways. The elytra are about 2 mm. wide at the base tapering slightly and rounded at the posterior end, about twice as long as the prothorax. (A technical description is given in Blatchley and Leng (1)). The general body color is black sometimes shading to dark brown or brick red. The ventral surface is ash-gray and thickly clothed with fine hairs. The elytra are covered with short, pitted, gray or brownish scales in distinct rows and rather thickly clothed with short, recurved hairs. In the centre and on both sides of the pronotum are indistinct, brown or gray, somewhat irregular lines. The beak is short, curved and thick, being nearly as wide as the thorax at its base and thickly clothed with hairs. The antennae are reddish, longer than the beak, but folding into it so as to be inconspicuous.

Egg. The egg is ellipsoid, nearly round, and slightly granular, .36 mm. in diameter. When first laid it is a light yellow color but in a few days it turns to a dusky black. The length of time required for this change varies inversely with the amount of moisture present. An average length of time required for the change is about 3 days.

Larva. The larva is a small, white, fleshy grub about .7 mm. long when first hatched, with prominent light-brown head. It is roughly rectangular, not tapering very much to the posterior end, which is broadly rounded. When full-grown the larva is about 5 mm. long, broad, heavy, and sluggish. It lies curved in a crescent shape when removed from its food plant.

Pupa. The pupa is white, sometimes with a slight yellow tinge, 4 mm. long, found curled in an oval cell about 5 mm. in diameter at a depth of ½–1 inch below the surface of the soil. (See also report by Webster (3)). The abdomen tapers gradually toward the posterior end on which are two prominent rather dark curved spines. After a few day's growth the eyes and later the beak turn brown, and finally, just prior to emergence the whole body is gray with yellow legs.

Methods of Procedure

Adults were collected in the field for all experimental work. To obtain egg records pairs were enclosed in glass or celluloid tubes about 1¼ inches in diameter and 6 inches long. The tubes were set in the ground, filled with soil to the ground level, and stoppered with cotton. The adults were fed on red clover or alfalfa leaves. The tubes were set among the plants in a clover field so as to be shaded part of the time. For general observations and habit studies five pairs were enclosed in each of a number of cylindrical wire mesh cages about six inches in diameter and 15 inches high, or 50 pairs were enclosed in wire mesh cages about 2 feet square and 18 inches high. Eggs for hatching records were taken from tubes that had been cleaned not more than 24 hours previous so that none were more than one day old at the start.

Larvae for the studies were collected in the field to some extent, but were obtained mostly by putting eggs from the oviposition tubes into a series of wire mesh cages over individual seedling red clover plants. Information regarding the length of the larval and pupal periods was obtained by digging and examining these plants at regular intervals. At first some were dug every day, but after a number of trials it was possible to make these examinations within a few days of when hatching of eggs or pupation of larvae was to be expected.

Life History

Adult. Adults are present in the field practically the entire year. In some seasons emergence has been observed as early as June 8th, other seasons it may be delayed until the first week in July. They are active until continuous hot weather sets in and are then inactive until early fall. During the first part of September active feeding commences, continues until freezing weather, and occurs during warm periods of the late fall and winter. Activity is renewed in the spring during the latter part of March and continues until death. Many adults die during the winter but the period of greatest mortality is after May 1st. Some may be found in the fields until the first or even the middle of June in a cool season. In general adults are most active when temperatures are between 50 and 75 degrees F. and oviposition is most general at that time, though eggs have been observed deposited with temperatures around 40 degrees F. They feed actively when first emerged and during oviposition periods.

Mating starts about the middle or third week in September and occurs during all active periods until death. It is promiscuous. In

several cases the males died during the course of the experimental work. When new males were supplied mating and oviposition proceeded as before.

The adults were able to undergo submergence in water for at least 24 hours and survive. This happened in a few cases during the course of the work. Several times they were frozen in solid ice and resumed activity when thawed out.

They seldom fly, but are capable of flights of considerable distances, having been collected on wheat at least a half-mile from the nearest clover. We have been unable to make them feed on wheat.

EGG. Oviposition commences in central Illinois generally about the middle of October, continues to the last of November or first of December, occurs occasionally during the winter, starts up again about the last of March and continues until the adults die. Occasionally eggs are found as early as the first of October. Fall oviposition by this species has also been reported from England (2).

The eggs are laid usually on the soil at the base of plants or under trash, or on the stems of plants and stipules of leaves, and have been found on grass in our cages. Both cage and field records show 80–90 per cent of them on the soil. They are laid both night and day. This was determined by removing the eggs from our oviposition tubes twice a day during four periods, both at sunset and soon after daybreak in the morning.

A long series of tests show the times and numbers of eggs laid. For brevity they have been reduced to the following table.

The records for 1925–1926 are for the same adults kept in the cages continuously from start of fall observations until death in the spring. The project started with 50 cages. Included in the records are only those that survived the winter and lived until at least April 29th. The cages were covered with straw December 15th and uncovered the last of February. During the 1926–1927 season we gave the cages no cover in order to observe the effect of exposure and winter habits. None survived after February 28, 1927. They were replaced early in March. The table shows the records of the original and replacement adults. Having once carried them through and knowing that they survive in freedom, we considered this fair. Again only those that lived until April 23rd were included in the record.

These records for the 1925-1926 season show that the 25 females laid a total of 3469 eggs during a laying period of about 92 days, an average of 139 eggs per female of 1.5 eggs per female per day. They show that 918 of these eggs were laid during the fall season and 2551

TABLE 1. RECORD OF OVIPOSITION OF *Sitona hispidula* FAB. IN ILLINOIS 1925–1927

	Number Females	Start Oviposition	Finish Oviposition	Number Days in Oviposition Period			Total Numbers Eggs Deposited	Seasonal Percentages	Number of Eggs per Female			Average Number Eggs per Day	Maximum Number Eggs per Day
				Maximum	Minimum	Average			Maximum	Minimum	Average		
Fall 1925	25	Oct. 12	Nov. 30	49	25	41.12	918	26.4	72	8	36.72	.89	9
Spring 1926	25	Mar. 19	May 31	74	32	50.60	2551	73.5	228	25	102.04	2.01	13
Total for Season[1]	25	Oct. 12	May 31	123	65	91.72	3469		269	33	138.76	1.51	13
Fall 1926	34	Oct. 14	Dec. 13	47	1	38.26	1565	27.5	113	1	46.02	1.20	12
Spring 1927	34	Mar. 28	June 7	69	4	45.44	4106	72.4	277	4	120.76	2.65	18
Total for Season[2]	34	Oct. 14	June 7	108	26	83.70	5671		365	15	166.79	1.99	18

[1]Same females throughout.
[2]Females replaced (see text, p. 000).

during the spring season, or 26.4 per cent during the fall and 73.5 per cent during the spring season.

The records for the 1926–1927 season show that a total of 5671 eggs were laid by 34 females during total laying period of about 84 days, an average of 167 eggs per female or two eggs per female per day. They show that 1565 of these eggs were laid during the fall and 4106 during the spring seasons or 27.5 per cent during the fall and 72.4 per cent during the spring seasons.

Eggs were not laid by each female every day during the laying period but a record of the days during which each did deposit eggs would be too cumbersome for the purpose of this paper.

These records were supported by field observations. To quote a few: Eggs were observed in the fields December 14, 1925, February 8, 1926, October 13, 1926, January 8, 1927, February 17, 23 and 24, 1927 and March 13, 16 and 26, 1927.

HATCHING. No eggs have been found to hatch in the fall, but eggs laid in the fall as well as eggs laid in the spring will hatch in the spring. Eggs were placed on 10 curculio-free alfalfa plants October 26, 1925. Several of these plants were dug April 19, 1926 and no larvae found. The other plants were dug May 1, 1926 and tiny larvae were found at that time.

Eggs were placed on three plants in the insectary October 26, 1926. Two of these plants were dug November 26, and no larvae were found. One larva and one pupa were found on the other plant when it was dug June 10, 1927. Our records show several other similar cases which will not be quoted here.

Fall-laid eggs require 138–200 days to hatch. The first hatching was observed May 1, 1926. In this case the eggs had lain on the soil or in the soil of a cage 139–200 days, depending on the date of laying. Hatching in 1927 was started at approximately the same date. In that case eggs required 138–192 days to hatch.

Eggs laid in the spring require 17–21 days to hatch early in the season, and 15–16 days to hatch late in the season. In the spring of 1926 eggs from oviposition tubes were placed on clean caged plants for hatching. From these larvae were found to have hatched 16–18 or 19 days later. In April, 1927 eggs were brought into the laboratory, placed on petri dishes lined with plaster-paris, and kept slightly moist in a temperature of 65–70 degrees F. Five lots of 20 eggs each were kept in this manner. In three cases the eggs hatched in 17 days, in one case 18 days, and in one case dead larvae were found that had hatched during an absence but were found 22 days after oviposition.

Eggs were placed on seedling red clover plants in the insectary from April 30 to May 21, 1927. The plants were dug at various intervals. Hatching was found to require 15–16 days.

LARVA. The larvae may be found in the soil of clover and alfalfa fields from 1 to 6 inches deep between the first of May and the middle of June during most seasons in the latitude of central Illinois. At the latter time many larvae may be expected to be in cells close to the soil surface ready to pupate. During the four years of observations no larvae have been found during the fall season. Immediately upon hatching the larvae enter the soil and begin feeding on the nodules of legume plants. Very young larvae were invariably found inside the nodules during the course of our studies. Larvae 1–2 mm. long are usually found with their heads inside a nodule on which they are feeding. Later the small roots are fed upon and operations are gradually extended until, when they are full grown they are sometimes found on the tap root burrowing and gouging irregular holes in it. This tap root feeding has been observed very few times during the period of our studies in Illinois.

LENGTH OF LARVAL PERIOD. In the spring of 1926 larvae were making cells for pupation May 21, where eggs had been placed on the 12th of April. We have shown the egg period at that time to be 15–18 days. This would leave the life of these larvae as 22–25 days up to the time of making pupal cells in the soil. May 31, 1926 pupae were seen where eggs had been placed April 19, 1926. This would make the larval life of these specimens 22–26 days long.

Insectary records in 1927 show: (1) larvae 21 days old not pupated; (2) pupae June 16 from eggs May 3, larvae about 26 days; (3) larvae June 4, pupae June 25, larval life 21 days; (4) larvae June 4, pupae June 25, larval life 21 days; (5) eggs May 21, pupae July 2, larval life 23–27 days. From these it will be seen that *Sitona hispidula* spends 21–27 days as a larva feeding on the nodules and roots of clovers and alfalfa.

PUPA. Pupae are found scattered in the soil either close to or as much as 5–6 inches away from the base of clover and alfalfa plants on which the larvae appear to have fed. They are very delicate and, unless handled with the utmost care, will be destroyed.

PERIOD OF PUPATION. Few of our records show definitely the time spent by this insect as a pupa, but certain of our materials can be adapted to show the approximate period. Some of the insectary plants which were used to determine egg and larval periods were left for pupae,

and others, undisturbed between deposition of eggs and emergence of adults may be used. These show: (1) pupation May 31, 1926, adult seen emerged June 22, 1926, pupal period 22 days or less (the plots were not visited for a few days); (2) pupae June 16, 1927, adult July 2, 1927, pupal period more than 16 days; (3) pupae June 25, adult July 20, 1927, period less than 25 days (had not been examined for several days); (4) pupa July 2, adult July 20, 1927, pupal period 18 days; (5) egg May 21, adult July 20, 1927, pupal period 17–20 days.

Pupation occurred in the field in 1926 and 1927 during the first ten days or two weeks of June. This coincided in both seasons with the first cutting of alfalfa for hay, and preceded the cutting of red clover for hay by two or three weeks

It is probable that the pupal period is longer in the field than in our insectary and cage tests. In 1926 pupae were observed May 31, and were present in numbers until June 17. Adults were first observed June 22, 1926. In 1927 pupation was not observed in the field until June 10, at which time the pupae were present in the ratio of 6 to 1 of pupae to larvae. The larvae were practically all in cells ready to pupate. First adults were observed in the field July 5, 1927.

In general the pupation period is seen to be between 17 and 22 days in central Illinois during June.

HIBERNATION. As previously shown, the Clover Root Curculio hibernates in the adult and egg stages. The adults are hidden in the leaves and trash in the clover and alfalfa fields. They have not been found in our many hibernation studies at the bases of hedges and fence rows, though these have been, in many cases, adjacent to clover fields in which the Curculio could be easily found.

PARASITES. Up to the present no larval or pupal parasites have been observed by us. One predatory insect, *Stenus* sp. (Staphylinidae) was taken feeding on the eggs of the Curculio at Riggston, Scott county, Illinois, April 12, 1926.

REFERENCES

1. BLATCHLEY and LENG, Rhyncophora of N. E. America, 1926, p. 141.
2. JACKSON, Miss D. J., Ann. App. Biol. Cambridge, IX, 2, June 1922.
3. WEBSTER, R. L., U.S.D.A.B. 649, 1915.
4. WILDERMUTH, V. L., U.S.D.A. Bur. Ent. B. 85, 1910.

MR. A. A. GRANOVSKY: I have been interested in the fact that insect injury leads to secondary invasion of plant parasites on clover and alfalfa. In my studies of the alfalfa "yellow top," I find that the roots are severely injured by depletion of reserve material in the root

system due to leafhopper feeding. The roots are weakened, and on repeated freezing and thawing during the winter are mechanically injured, and in the spring invariably succumb to alfalfa wilt, which is a bacterial disease. Since wounds are absolutely necessary for the entrance of bacterial wilt organism into the roots of the plant, the clover root curculio and other insects undoubtedly play an important role in the dissemination of alfalfa wilt and possibly other diseases. I would like to call Mr. Bigger's attention to this phenomenon and shall be interested in the results of his observation.

PRESIDENT T. J. HEADLEE: The next paper is by A. F. Satterthwait.

ANAPHOIDEA CALENDRAE GAHAN, A MYRMARID PARASITE OF CALENDRA

By A. F. SATTERTHWAIT, *Webster Groves, Mo.*

(Withdrawn for publication elsewhere)

PRESIDENT T. J. HEADLEE: The next paper is by G. M. List.

SOME EXPERIENCES IN BREEDING *TRICHOGRAMMA MINUTUM* RILEY

By GEORGE M. LIST, *Colorado Agricultural Experiment Station*

ABSTRACT

An account is given of 2 years experience in breeding *Trichogramma minutum* Riley, by using *Sitotroga cerealella* Ol. eggs as the host. Mites which proved a serious menace to the supply of *S. cerealella* have been controlled by sulphur. Low humidity prevents many *S. cerealella* larvae from making entrance into the grain. The ratio of reproduction of *T. minutum* Riley has varied a great deal. The presence of sulphur is a factor in this, but the condition may prevail when sulphur is not used. *S. cerealella* eggs are somewhat more readily parasitized after being stored in a refrigerator. They have been parasitized successfully after being held for 82 days at a temperature of 38 degrees Fahrenheit.

A project in the breeding of *Trichogramma minutum* Riley was started by the Colorado Experiment Station and State Entomologist cooperating, in August 1927. The object was to determine if this parasite could be made of more value in the handling of our rather extreme codling moth condition of certain sections of the state. The work has been pushed rather vigorously for over two years with only indifferent results, but since a number of other workers are interested in the same study, it is feltthat a brief account of some of our experiences may be of interest.

The technique used has been developed largely from that of Mr. Stanley E. Flanders, of California, and a number of suggestions from A. B. Baird and Geo. Wishart of Ontario. The writer was assisted in the laboratory during the winters of 1927–28 and 1928– 29 by Mr. W. P. Yetter, Jr., and during the remainder of the time by Mr. Carl Bjurman. Mr. Yetter handled the liberation of the parasites in the orchard during 1928 and Mr. Louis G. Davis during 1929.

A number of hosts have been tried out but *Sitotroga cerealella* Ol. has proven the most adaptable to large scale breeding work, and what I have to say here will refer to that species. Our original supply of *Sitotroga cerealella* Ol. was secured from a grain storage room on the College campus. Later several thousand eggs were sent us by Mr. S. E. Flanders of California.

Our supply of *T. minutum* was secured by collecting parasitized codling moth eggs in the orchards at Grand Junction during the late summer of 1927. They have been bred continuously under artificial conditions since that time. However, other material secured from the following sources was added; Stanley E. Flanders, Saticoy, California, spring of 1928; A. B. Baird, Chatham, Ontario, spring of 1929; and from the orchards at Grand Junction, Colorado, during the late summers of 1928 and 1929. It is not known how effectively the introduced material interbred with that on hand.

Some ten different grains have been tried in the *Sitotroga* breeding, but corn and wheat have proven the most practical and have been used almost exclusively. The larvae seem to prefer wheat to the corn or else they are able to make entrance into the grains more readily. The moths bred from wheat, however, are smaller than those from corn and not so desirable.

The grain has been handled in bins 48 inches long, 26 inches wide and 3 inches deep, covered with slats ⅛ of an inch apart. These are stacked in piles 8 high on an incline of about 30 degrees with the stacks arranged with an aisle 24 inches wide. A large percentage of the moths work upward into this aisle where they are collected by means of suction from a vacuum sweeper. Bins of the size used are too long to handle most easily and the grain in the center has not been as heavily infested as nearer the ends. The following two types of cages for egg produciton have been found the most satisfactory.

1. This has been described and used successfully by Flanders. Ours consisted of a tin or cardboard cylinder 7¼ inches in diameter, 10 inches high with caps made of 20 mesh screen. These are placed before a fan so a gentle breeze will go upward through the cylinder. This acts as a

stimulant to oviposition and the eggs drop through the lower screen and fall beneath the cage.

2. This is a standard 6 by 8½ battery jar. Its use has been developed largely by Mr. Carl Bjurman. The moths are taken directly into it by the suction collector and retained by an inverted manilla paper cone that fits snugly in the top. The egg-laying device is based on the theory that the moth naturally pushes her eggs into crevices or places where there is a certain amount of friction on the tip of the abdomen. This condition is made by wrapping a manila paper cylinder, 3½ inches in diameter and 5 inches high in a spiral fashion with a $\frac{5}{16}$ inch tape of medium to light celluloid leaving ¼ inch between the spirals. The celluloid should be slightly curved laterally. This can be done by cutting both edges of it from the same side and by pressing the strip through its entire length with some dull round pointed instrument as a nail punch. The convex side of the tape is then wrapped against the cylinder thus leaving each edge slightly raised. This makes crevices to the liking of the females and their eggs are pushed under the tape from both sides. When the tape, which has been fastened at each end by a paper clip, is removed, practically all the eggs adhere to the cylinder. They can be handled on this paper or brushed off with a medium stiff brush.

A cylinder of the size mentioned will take a tape about 6 feet in length and almost 50 per cent of the cylinder surface will be available for egg laying. Some three or four notches should be placed in the lower end of the cylinder so the moths can crawl in and out. We have found it advantageous to drop a second cylinder that has a ¾ inch greater diameter, over the one with the tape, as the moths like to congregate out of the direct light. If desired several cylinders of different diameters, all wrapped with the tape, can be placed in one jar. However, the one cylinder will furnish egg laying surface for from 5000 to 8000 moths if a new cylinder is given each day. This cage has the advantage of preventing all useless waste of energy by the moths. They are seldom seen fluttering or even crawling about, and an increased egg production is the result.

The angoumois grain moth is a more serious pest in the more humid sections. We find our low relative humidity of the semi-arid section a great handicap in the breeding work. The greatest difficulty from this lack seems to occur with the newly hatched larvae as they are unable to make entrance into the grain. In a recent test in which 500 kernels representing five different kinds of grain were exposed to 500 newly hatched larvae in a classroom with the relative humidity in the

neighborhood of 20 per cent, not a single larva made entrance. In a duplicate test made with a relative humidity of from 35 to 50 per cent, 37 or about 7½ per cent made entrance. While in an incubator with the relative humidity in the neighborhood of 80 per cent, 338 or more than 56 per cent entered.

We are attempting to maintain a higher humidity in the main breeding laboratory by forcing a current of air through a fine spray of water in the summer time and by introducing steam into it during the colder weather. This is only partly satisfactory. In order to overcome this great loss of the newly hatched larvae while infesting a new supply of grain for spring moth production, small quantities of it are kept in an incubator where the humidity can be maintained at about 80 per cent with a temperature of 80 to 85, until all the eggs on the cards have hatched and the larvae have made entrance.

Another very serious problem in the production of the parasite host has been mites. Our first experience came in March of 1928 when our infestation was so badly reduced that the parasite breeding work had to be almost discontinued. Two species of mites were responsible, one an undetermined Gamasid and the other *Pediculoides ventricosus* (Newport). The latter became so numerous that workers in the laboratory had considerable trouble with the characteristic hive-like body eruption that they cause. Much work has been done in order to avoid or to control these mites. It was found that certain sulphurs were quite effective in destroying the mites when very young but none of the sulphurs destroyed the older individuals. Preliminary results of these tests were reported in "Scientific Notes," JOURNAL OF ECONOMIC ENTOMOLOGY, Vol. 21, No. 6, December, 1928. It has been interesting to note that only two sulphurs of a number of samples tried, were effective. One was from a sack of dusting sulphur that has been on hand for six or eight years. Its origin is unknown. The other is a by-product sulphur. Two suggestions have been offered as to why these two sulphurs were the more effective. The first is that they were of finer particles and exposed a greater surface area, but the manufacturers of the other samples will not admit this. The second suggestion is that the old sample which was the more effective and the by-product sulphur were more acid, but tests showed two ineffective samples to be the most acid. The mites are now well under control. We occasionally see one of the Gamasid mites in the laboratory but they have not increased during the last eight months and are not numerous enough to do appreciable injury. The *Pediculoides ventricosus* has not been taken in the laboratory since last March. At that time the laboratory

was thoroughly cleaned and fumigated and a supply of grain brought in with which every precaution had been taken to keep it free from mite infestation. This precaution and the presence of sulphur seem to be responsible. We are, however, planning to infest smaller quantities of grain in the future, and get these infestations as high as possible with the idea that the moth production value of the grain can be secured in about two or three generations, thus permitting a quicker turnover. This may even enable us to keep the mites under control without the use of sulphur.

A number of difficulties have been encountered in the handling of *Trichogramma minutum* Riley. Many variations in the method have been tried. The best result has been by exposing the *Sitotroga* eggs to the *Trichogramma*, under a Petri dish inverted upon plate glass, blotter paper or soft cloth with an artificial light from 20 to 30 inches above. With a temperature of 80 to 83 degrees the *Trichogramma* will develop in 8 or 9 days. The petre dish has proven too small a unit for large scale production so we have been trying, with very good success at times, a 4 by 5½ inch battery jar. These can be inverted upon a soft cloth to prevent the escape of *Trichogramma* on account of irregularities of the top, and the unit capacity much increased. These are of such a size that the egg cylinders described above can be used without the eggs being transferred to the small cards as used in the petri dishes. By using egg cylinders of slightly different diameters, several can be placed in one cage and a hundred thousand or more eggs exposed at one time.

Our greatest difficulty has been a very irregular rate of reproduction. This has not varied so much with different cages of the same date, but has gone in more or less definite cycles of considerable length. At times we have had difficulty in maintaining a reasonable amount of breeding stock while at others the rate of increase has been all that could be desired and our supply of host eggs was the limiting factor. Our first real serious decline of this nature came in July, 1928, shortly after the laboratory had been dusted with sulphur. The natural conclusion was that the sulphur in some unknown way was responsible. We are still convinced that it has been a factor but possibly not the only one. Since the fall of 1927 we have had six periods when poor reproduction was secured. Two of these occurred when sulphur was not being used, and we should state good results have been secured with eggs from moths reared in sulphured corn. During last August, September and October, our rate of reproduction was easily 4 to 1 and some times higher. This began to decline during November and at the

time of writing we are having difficulty in getting a ratio of reproduction of 1 to 1. The same methods and equipment are being used, and the eggs are produced from moths coming from the same bins in which the grain was dusted with sulphur at the time they were filled. In addition to this a small supply of eggs has been available from a source free of sulphur. The parasitism has been only slightly better than with the eggs coming from sulphured grain.

It has been interesting to note that eggs placed in cold storage for a few days are better parasitized when exposed than fresh ones. From 4 to 15 days at a temperature of 38 to 40 degrees Fahrenheit show the best results. The parasitism, however, continues good much longer. A good parasitism of 62 day old eggs and a limited parasitism of 82 day old eggs has been secured.

The *Trichogramma* that were reared from the eggs that were parasitized after 62 days were about 12 hours longer in developing than others reared from fresh eggs. In this particular case the adults seemed quite normal and gave a good ratio of increase when given eggs. The eggs should be stored where the moisture is high enough to prevent rapid desiccation. An electric refrigerator is too drying unless a special moisture chamber is provided. This method of storing the *Sitotroga* eggs offers great possibilities in meeting demands for large numbers of *Trichogrzmma* for a definite time.

The idea was suggested that possibly under our conditions there was a toughening of the chorion to a point where parasitism was impossible. Working along this line Mr. Leslie B. Daniels, developed a method of determining quite accurately the gram weight necessary to puncture eggs with a point of given size. A paper given on this work by Mr. Daniels at the 1929 Rocky Mountain Conference of Entomologists shows that there is a considerable variation. For example Canadian eggs received through the cöoperation of A. B. Baird, Chatham, Ontario, showed an average penetration of .416 gram while with the Fort Collins eggs of approximately the same age, it was .785 gram, or it took 1.8 times more pressure to puncture the Fort Collins eggs. In another case eggs received from moths reared at Fort Collins, but from Canadian material showed an average penetration when 24 hours old of .658 gram in comparison to 1.028 grams for eggs from Fort Collins material. There is an increase in the gram weight necessary to penetrate eggs as they get older when kept in our moth rearing laboratory, as the following averages will indicate: 24 hours, 1.02 grams, 48 hours, 1.01 grams, 72 hours, 1.04 grams, 96 hours 1.18 grams, 120 hours, 1.27 grams and 144 hours, 1.34 grams.

The placing of eggs on a moist blotter slightly softens the chorion. Refrigeration does likewise, the moist chamber having a greater effect than a dry one. The average gram weight necessary to penetrate eggs 48 hours old directly from the moth rearing laboratory was .51 gram. After 24 hours under moist refrigeration it was .436 gram and under dry .4 gram. After 48 hours under the same conditions it was for the moist chamber eggs .286 gram and for the dry .414 gram.

Knowing that the *Trochogramma* breeds in such a large range of host eggs it hardly seems likely that its ability to puncture eggs of a single species would be so limited, however, the study is of sufficient interest to carry farther.

The storing of *Trichogramma* under refrigeration has not been very effective. From our observations best results are secured when they are placed in the refrigerator on the 5th or 6th day of an 8 day development period. The humidity should be quite high and the temperature from 35 to 40 degrees Fahrenheit. While some adults have emerged after 60 days storage there is a marked weakening after 20 days.

Our orchard liberations have not been in numbers enough to show positive results. In 1928 the liberations were all quite early in the season when first brood codling moth eggs were present. The weather conditions at the time were rather adverse. The parasitism in the orchard was no higher than in other orchards of the general section. Liberations on the second brood eggs in 1929 seemed to show some results but the liberations could not be extended over a sufficiently long period to make a reliable test. Codling moth eggs on apple leaves, placed loosely in a battery jar, have always been well parasitized when exposed to *Trichogramma*.

MR. J. L. HORSFALL: It might be of interest right here to relate an experience which Dr. Moore and myself experienced in breeding moth larvae in connection with moth proofing tests. We ran into the difficulty of mite infestation which reduced our stock of moth larvae almost to extinction. We used rabbit fur as a medium for breeding the larvae. We finally hit upon the same scheme, using the fine dusting sulphur, mixing it with rabbit fur, and the breeding has increased to a pace which is now satisfactory.

MR. W. E. HINDS: The difficulty experienced has not been that the use of sulphur decreased the deposition of eggs of the moth, but the parasite declined to attack the eggs of the moth where the sulphur had been used.

PRESIDENT T. J. HEADLEE: That was our experience with Trichogramma on the Oriental peach moth this summer.

We will now take up a paper by J. H. Hawkins.

WIREWORM CONTROL IN MAINE

By J. H. HAWKINS, *Agricultural Experiment Station, Orono, Maine*

ABSTRACT

The wheat wireworm, *Agriotes mancus* Say, is a serious pest to Maine crops. An upland species of the genus *Melanotus* is second in importance. Certain cultural practices and immune crops have been found to be effective in checking wireworm infestations. Meadows and oat fields seem to be favorite breeding grounds for the wheat wireworm. Clover, buckwheat, and peas are resistant to the attacks of these insects and potatoes are very susceptible. Fertilizer is useful in strengthening plants to withstand wireworm attacks. Drainage is helpful in controlling the wheat wireworm and fall plowing is but partially effective.

The wheat wireworm, *Agriotes mancus* Say, is the most widely distributed and destructive wireworm infesting the field and vegetable crops of Maine. Another wireworm belonging to the genus *Melanotus* has appeared during the last year in great numbers, completely destroying large areas of sweet corn on one farm. This species, although distributed over a large section, has not before been recorded as being so destructive as *A. mancus*.

Potatoes are damaged yearly by wireworms mainly in two ways. Soon after planting the seed pieces are often burrowed and a poor stand results, or there may be little injury apparent until the potatoes are nearly ready to dig. The wireworms may then bore holes in the tubers, sometimes causing small pits or they may tunnel deep into the inside, spoiling the market value of the crop in either case. Injury may be done to the seed soon after planting. Feeding wireworms may also stunt the plant, prevent it from reaching maturity, weaken the root system so that it topples over during strong winds, or the plant may be killed outright. Nearly all garden and field crops are attacked by wireworms. Resistant plants will be noted later.

Control of wireworms by soil fumigation, stomach poisoning, or by repellent action of chemicals has not yet proven entirely satisfactory under existing climatic and soil conditions of Maine. Baiting as a means of controlling the adults of *A. mancus* is a method to be encouraged. Chopped clover placed under boards and stones is effective. Poisons used in connection with these baits have not yet proved to be effective. Baiting as a control measure for the larvae of *A. mancus* has been found effective. Sprouting wheat has been found the most efficient of the baits tried, attracting an average of 25 wireworms per bait. Honey or molasses added to graham flour dough increased the value of graham flour baits and made them second to wheat in attractiveness. Sprouting corn was also effective in attracting wireworms. How-

ever, baiting involves much hand labor and unless these insects may be killed by poisons eaten with the baits, such a control method is not likely to become general.

Preliminary experiments and observations indicate that certain cultural practices are at least partially effective in control of these pests. Meadow land plowed up in May, 1928, after the grass had considerable start, was used for experimental plots in cultural methods of wireworm control. Larvae of *A. mancus* were found scattered throughout the soil at the time of plowing and later, but apparently the stand of grass in the meadow had not been affected by their feeding. This was due, no doubt, to the large amount of vegetation present. Silage corn, sweet corn, potatoes and oats were then planted. Slight injury was noted to corn and oats, but potatoes alone were seriously injured. Early in the season some of the seed pieces were so badly burrowed that an uneven stand resulted. Later wireworms fed upon the growing tubers in such numbers that mature potatoes were practically worthless. Except for a strip of meadow and plots where oats were grown, the entire field was plowed during the fall of 1928. Sweet corn, silage corn, oats, potatoes and buckwheat were planted for 1929 crops. Again early season injury by wireworms was light. Although wireworms were plentiful in the soil, there was not sufficient concentration to cause a large amount of injury. Later in the season injury was apparent when potatoes were nearing maturity. Plots for 1929 were planted crosswise of 1928 plots and the 1929 infestation varied with previous crops and treatment. The heaviest infestation (at the rate of 21,000 per acre) was in potatoes in soil which had been planted to oats during 1928. A plot nearby which had been kept fallow during 1928 was found to have the wireworm population reduced at the rate of 13,000 per acre.

Wireworms at the rate of 7,200 per acre were found in lighter soil where potatoes were grown following a 1928 crop of potatoes. Previous to 1929 this soil was not so heavily infested as plots already mentioned. There were some wireworms present in soil of corn plots, but they were more widely scattered than they were in the potato plots. Soil planted to buckwheat produced a few wireworms, but those present were deep in the soil and apparently many of them had migrated to nearby plots whenever possible. It is significant that no young wireworms from this year's crop of eggs were taken in the cultivated plots. This circumstance corroborates other data on the ovipositing habits of the wheat wireworm in Maine. Apparently very few eggs are laid in fields kept in cultivated crops. This, coupled with the fact

that wireworm infestation often follows cultivated crops planted in soil plowed from meadow lands, is an argument against including hay crops such as timothy or other similar grasses which may stand for several years, in the rotation. Clover has been found to thrive even when wireworms are present in large numbers and is desirable if a hay crop must be raised. Peas planted in infested soil are also resistant to wireworms and may be included in such a rotation. If a pea crop is planted in rows and cultivated, it is an especially good one to be grown in wireworm infested soil for peas are resistant to wireworm attacks and cultivation discourages congregation of the adults for breeding. Oats are not severely injured except during years of exceptional wireworm abundance, but data seem to indicate that the adults deposit eggs in oat fields. Corn may be severely injured, although it can sometimes be safely grown in the rotation the second year following sod. Available data on the subject indicate that the limit of tolerance of sweet corn to wireworm injury is considerably greater than that of potatoes. In case of heavy wireworm infestation both corn and potatoes are to be avoided. Either peas, or clover, or buckwheat is a desirable crop for the first two years after the field has been plowed from meadow, if the wireworm population is large. Wireworms are capable of some migration and a small field or garden may continually be infested by wireworms from nearby sod land. This has been demonstrated by counts of areas bordering meadow land before placing of cyanide barriers, after they had become ineffective, and by observations of small areas surrounded by meadows. Wireworms were also induced to move down a glass tube toward a corn plant by drawing a draft of air from the plant to the wireworms, indicating that they are able to locate food by perception of odor.

The wheat wireworm inhabits low lying places and drainage has been recommended as a control measure for this species. Data collected are insufficient at present for definite conclusions, but in at least one case drainage has reduced the number of wireworms present. An undrained area, of the same soil type and which received the same general treatment in regard to farm operations on the drained area, was used as a check.

Fertilization as a method of producing crop resistance is applicable in wireworm control. At least data were obtained in one field infested by the upland wireworm, *Melanotus* sp., which bear this out. Fertilizer used judiciously stimulated growth of sweet corn and a heavy yield resulted, even though the wireworm population ran into several thousands per acre.

Fall plowing is of some value, but is not wholly effective as a means of controlling the wheat wireworm. Theoretically the pupal stage is the most vulnerable spot in the life history of this pest. In order to attack it in this stage, however, plowing would have to be done during August. Since crops are growing at this time, such a practice is not feasible. Then too, pupae of this species can stand rough handling without much damage as was demonstrated when they were dug from the ground and placed in containers in a greenhouse. Here, without special care they continued to develop to the adult stage, the rate of mortality being very low. At the time most fall plowing is done, pupae have changed to adults within the pupal cells where they spend the winter. Plowing disturbs the adults by breaking them from these cells and exposing them to the weather. If plowing is done late in the season when the weather is cold enough, the beetles evidently are not able to again enter the soil and may perish. It is interesting in this connection that bettles died in the insectary during the winter of 1927 where except for moisture, approximately outdoor conditions prevailed. Fall plowing has been observed for effect upon the larvae of both *A. mancus* and *Melanotus* sp. No direct mechanical injury by the plowing operation has been found. Those larvae exposed again entered the ground, unless as sometimes happens, they were eaten by birds following the plow.

MR. P. T. ULMAN: I should like to ask Mr. Hawkins if he has observed the larvae on gladioli. My attention was called last summer to rather severe infestation of gladioli, especially to the new corms.

MR. J. H. HAWKINS: I think I have one or two records of injury to gladioli.

MR. P. T. ULMAN: The wireworms seem to burrow in the old corms rather than the new.

MR. J. H. HAWKINS: I have one or two records of injury to gladioli but do not remember having observed such injury personally.

PRESIDENT T. J. HEADLEE: The next paper is by Walter Carter.

ECONOMIC APPLICATION OF INSECT-ASSOCIATION STUDIES

By Walter Carter, *U. S. Bureau of Entomology*

Abstract

Studies of insect associations supplement standard methods in economic entomology. They provide data on biology of species, host-plant relationships, relations between climate and species, cyclic phenomena, plant-disease vectors, and the control of waste lands as reservoirs for economic and potentially economic insects.

Of the three lines of attack on entomological problems, one has probably been used almost exclusively in the past. This is what might be termed the "life-history" method and considers simply the insect, as such. The development of well-equipped laboratories has extended this method to include consideration of the effects of single environmental factors or of two or three of these in combination. In accordance with the standard scientific procedure from the detailed to the general, this method will no doubt remain of fundamental importance.

Within recent years the second line of attack has been much used. This depends for its success on the concept that the insect is an integral part of an environment. The simplest development along this line has been the study of particular species in relation to climate. When the environment is taken to include the host plant, the problem becomes much more complicated, but consideration of the host plant is essential in some cases, notably those where the insect is a plant-disease transmitter, or where there are alternate hosts, or where the insect is a migrant.

The third method has rarely been considered in connection with economic problems. Studies of insect associations have usually been considered purely academic, resulting in mere lists of species from some particular locality, or host plant. Such studies belong to the pre-quantitative days of ecology and are anathema to the taxonomists on whom the burden of species determination falls.

Such studies can be planned and executed to yield valuable economic data. This method is essentially an extension of the one just discussed. There, the insect is considered in relation to its physical and biotic environment. In this case, the entire insect community is so considered.

This method differs from the previous one principally in concept, since the insect community can be known only through its parts, that is, the individual species comprising the community. The reactions of each species are considered, however, not as isolated phenomena but in relation to the reactions of other species with which it is associated. In such a study every single species encountered is at least potentially significant even though its numbers may be so few as to eliminate it

from statistical analysis. The terms "incidental" and "errant" species should be used only for convenience in designating those species which appear rarely or in very small numbers, and it is unwise to attach any other meaning to the terms.

Data on the insect community can often be obtained at little extra cost in the course of investigations on economic insects.

Routine work on the sugar-beet leafhopper, *Eutettix tenellus* (Baker), requires that sweepings be made at regular intervals at six or seven stations on from two to four host plants; in addition, regular circuits are made between these stations. All the insects taken in these sweepings are sorted and counted.

It is recognized that such a method, or any one quantitative method, as far as that is concerned, is not adequate for getting a complete picture of all the species inhabiting an area. As a matter of fact, much interesting material is lost unless such methods are supplemented by general "collecting."

The regular sweepings do, however, give comparable sets of data, the value of which increases rapidly as successive years' data are accumulated. The applications for these data can be briefly considered:

Additions to our knowledge of the biology of species, many of which are known at present only as museum specimens. Aestivation shows clearly in the data from collections as does double broodedness. Host-plant preferences and movements from one host to another, extremely important considerations in connection with insect-borne plant diseases, are clearly shown by the data if care is taken to choose stations where pure stands of the host plants are growing. A wealth of material is available for the study of parasitism and of competition between species.

In studies on climate and insects, the insect-association study offers a rare opportunity for extending our knowledge. An area will show in the association a relatively small number of species present in large numbers and a large number of species present either rarely or in small numbers. It is assumed that the common species in any locality are common principally because of favorable climatic factors and the presence of suitable hosts. By the same token, the so-called incidental species are inferior numerically because of climatic factors under which the species can barely exist or because of limited or unfavorable food. Even the common species fluctuate in numbers and these fluctuations can be associated with different types of weather. A cool late spring, for instance, in the Twin Falls area will reduce the numbers of *Eutettix tenellus* and increase populations of cutworms and the seed-corn maggot, *Hylemyia cilicrura* Rond. Some species which normally appear only

in the outer ring of incidental species take rank as common species during years of abnormal weather. This abnormality may be in precipitation or in temperature, for instance, or merely in the incidence of these factors.

With data available for a series of years, the effects of climate and weather on the species concerned will be determined, not only in general terms but also with respect to individual factors. It might not be amiss to make a suggestion here concerning the relations such studies should bear to laboratory experiments.

Any student of autecology who has attempted to apply to a field problem the results of laboratory experiments on the effects of single climatic factors is aware of the difficulties encountered in relating the two. If the laboratory experiments, however, are based on field data they not only are more easily related but serve as a check on interpretations placed on the data from the field. From field to laboratory is a much more economical procedure than from laboratory to field.

Cyclic phenomena appear clearly in the association data. These may be of two kinds, one as a result of a combination of weather types, another more or less independent of weather and inherent in the species. It is only through study of the data of a series of years that information regarding cyclic phenomena can be obtained. Once obtained, however, the prediction of insect outbreaks can gradually be extended to include many pests of periodic importance.

Diseases of plants transmitted by insects appear prominently in association with large populations of the latter, consequently the field of investigation where specific vectors are being sought can be narrowed down materially.

There is another economic application of such data which may be of far-reaching consequence. In proximity to some of the western irrigation districts of Oregon and southern Idaho are large tracts of abandoned land. These tracts at present are largely responsible for sugar-beet leafhopper outbreaks in this section and are a tremendous reservoir for insects of all kinds. The remedy for this condition lies primarily in restoring these tracts to their original status as sagebrush-grass lands. The method of approach that is being used in investigations by the Bureau of Entomology having this object in view is through a combination of studies of plant and of insect ecology, undertaken in collaboration with the Bureau of Plant Industry. The Bureau of Plant Industry's work on the plant ecology was initiated in the spring of 1928 when Mr. R. L. Piemeisel set up a series of studies on plant succession in the Twin Falls area.

The host plants on these lands could be attacked by introducing insect species not represented at present in the association.

Species of plants could be introduced which would replace the host plants. In either case a detailed knowledge of the insect community is essential. Reference has already been made to the so-called incidental species whose numerical inferiority may be due either to unfavorable climate or to lack of suitable hosts. It can readily be seen that the introduction of a new host plant might change the status of an insect species in the latter class with unfortunate results for the introduction. A practical example of this was experienced last season. A new plant, a willow herb, appeared at one of the stations. A chrysomelid beetle which previously had been an insignificant member of the association attacked the newcomer, with the result that there was a large although temporary increase of the insect and the new host plant was practically eliminated. It is obvious, then, that plant introductions must be made only in the light of detailed knowledge of the insect association, and this is true in even greater measure if introduction of insect enemies of the host plants is to be successful.

If associational studies are conducted in connection with economic projects the only additional cost is for the routine labor necessary to handle the sorting and counting of the insects. But such studies are well worth undertaking as separate and independent projects, since it is certain that results of wide economic application will follow.

President T. J. Headlee: We will now hear a paper by F. C. Bishopp, E. W. Laake and R. W. Wells.

EXPERIMENTS WITH INSECTICIDES AGAINST CATTLE GRUBS (HYPODERMA SP.)

By F. C. Bishopp, and E. W. Laake, *U. S. Bureau of Entomology, Washington, D. C.*

(Withdrawn for publication elsewhere)

Mr. C. L. Metcalf: I should like to ask the method of application. Do you rub it into the grub holes in the animal?

Mr. F. C. Bishopp: The method of application consists of applying the dust with a shaker can and working it in with the fingers. We feel that the thoroughness of the applications is of much importance.

Mr. F. E. Whitehead: Are these other materials so much better than sodium fluoride?

MR. F. C. BISHOPP: Our experience with sodium fluoride has indicated that it is not a satisfactory material for cattle grub control; not as satisfactory as the other insecticides which I mentioned.

ADJOURNMENT: 12:10 P.M.

Wednesday Afternoon Session, January 1, 1930

The session convened at 1:30 p.m., President T. J. Headlee presiding.

PRESIDENT T. J. HEADLEE: The first paper is by F. L. Campbell.

A COMPARISON OF FOUR METHODS FOR ESTIMATING THE RELATIVE TOXICITY OF STOMACH POISON INSECTICIDES

By F. L. CAMPBELL, *U. S. Bureau of Entomology*

ABSTRACT

The relative effect of acid lead arsenate and sodium fluosilicate on the silkworm was studied by three laboratory methods, namely, the sandwich method for the estimation of the median lethal dose, the sandwich method for the determination of the relation between dosage and speed of toxic action, and the simple cage test. The relative effect of the same compounds on mosquito larvae, *Culex pipiens* L., was studied by the method of Marcovitch.

It was concluded that only the first two of the foregoing methods measure the relative toxicity of stomach-poison insecticides and that the first of the two is the more practicable for the purpose. The last two methods may be suitable for measuring the relative effectiveness of stomach poisons. The cage test with appropriate insects should usually be the better of the two for this purpose.

The toxicity of sodium fluosilicate to the fourth-instar silkworm ranges from one to two times that of acid lead arsenate, depending on the method and criterion employed for its estimation. Any dose of the fluosilicate affected the silkworm more rapidly than the same dose of the arsenate.

In order to establish the toxicology of stomach-poison insecticides on a firm foundation, the toxicity of a large number of compounds should be quantitatively determined by a single good method. Since different methods give different results of varying degrees of reliability and general significance, it is desirable to make a comparative study of several methods in order to select the one best adapted for a general survey of relative toxicity. For this purpose the effects of acid lead arsenate and of sodium fluosilicate were compared by four laboratory methods.

INSECTICIDES AND INSECTS

The sample of acid lead arsenate ($PbHAsO_4$) used by the writer was carefully prepared and analyzed by C. M. Smith of the Insecticide Division, Bureau of Chemistry and Soils. It contained 33.01 per cent

As_2O_5 and 64.15 per cent PbO with about 0.04 per cent N_2O_5, 0.02 per cent moisture, and 0.08 per cent water-soluble As_2O_5. Mr. Smith also contributed a sample of sodium fluosilicate containing 99.5 per cent Na_2SiF_6. Both compounds were therefore very nearly pure.

Silkworms of the fourth instar weighing between 0.3 and 0.4 gram were used as test insects in the first three of the four methods to be discussed. Larvae of a mosquito, *Culex pipiens* L., in the last instar were used in the method of Marcovitch (*3, p. 33*). They were reared in jars to which dried blood had been added as recommended by Marcovitch (*3, p. 26*).

The Sandwich Method for the Estimation of the Median Lethal Dose

The sandwich method has been described in detail by Campbell and Filmer (*2*). It is sufficient to mention here the few refinements that have been made in the method since it was published. In the dusting apparatus a bell jar was substituted for a battery jar and the wooden top of the dusting stand was replaced by a piece of plate glass with a hole bored through the center to admit the blast of dust into the bell jar. The dust that falls on this plate can be swept up and used again if the quantity of the sample to be tested is so small that conservation is necessary. Instead of placing the cover glasses directly on the glass plate bearing the leaf disks, they were placed on pieces of black paper glued to the plate. The paper prevented the cover glasses from sliding on the plate, and raising them slightly above the surface of the plate made them easier to pick up with forceps.

Table 1 shows that all larvae that took doses less than 0.07 mg. per gram of body weight recovered and all that took doses more than 0.10 mg. per gram died. The numbers of larvae in these sublethal and lethal zones have no significance except to show the numbers that were wasted in order to delimit the significant intermediate zone in which some larvae died and others recovered. The numbers of larvae in the intermediate zone, however, are important for the determination of the median lethal dose,[1] the dose that kills 50 per cent of the insects. The intermediate zone of Table 1 shows that the dose of both compounds that

[1]Trevan (*5, p. 190*) proposed the expression, median lethal dose, and defined it as "the dose which kills 50 per cent of a large group of animals." It is more significant than the older expression, minimal lethal dose, a single definition for which has never been generally accepted. Moreover, the median lethal dose is not so variable as the least dose required to kill all or nearly all the individuals of a group and may therefore be determined accurately with fewer individuals.

kills 50 per cent of the insects lies between 0.07 and 0.10 mg. per gram. The writer realizes that the number of insects in the intermediate zone are too few, especially in the case of sodium fluosilicate, to permit more than a guess as to the value of the median lethal doses. It is certain, however, that these doses are nearly the same for both compounds and are not far from 0.09 mg. per gram. By this method the two compounds are therefore roughly equal in toxicity.

TABLE 1. THE EFFECT, IN TERMS OF DEATH OR RECOVERY, OF DOSES OF ACID LEAD ARSENATE AND OF SODIUM FLUOSILICATE ON SILKWORMS OF THE FOURTH INSTAR

Zone	Dose	Acid Lead Arsenate		Sodium Fluosilicate	
		Died	Recovered	Died	Recovered
	Mg./gm.	*Number*	*Number*	*Number*	*Number*
Sublethal.....	0.02	—	2	—	3
	0.03	—	2	—	3
	0.04	—	7	—	3
	0.05	—	3	—	8
	0.06	—	10	—	2
Intermediate..	0.07	1	7	1	2
	0.08	2	7	1	3
	0.09	4	6	1	1
	0.10	5	3	4	1
Lethal.......	0.11	10	—	1	—
	0.12	13	—	4	—
	0.13	10	—	3	—
	0.14	12	—	1	—
	0.15	7	—	7	—
	0.16	7	—	5	—
	0.17	10	—	3	—
	0.18	5	—	3	—
	0.19	4	—	1	—
	0.20	8	—	2	—

The best way to determine median lethal doses was suggested by Trevan (5). A curve showing the relation between dosage and percentage of mortality is plotted and the dose required to kill 50 per cent of the animals is read off from the curve. According to Trevan it is desirable that each point on the curve should represent the percentage or mortality of at least 30 animals. Because doses can not be exactly predetermined in the present method, it would require hundreds of insects and much time to cause at least 30 insects to take each of the doses in the intermediate zone. In the initial stage of the development of the toxicology of stomach-poison insecticides it is questionable whether it is necessary to determine median lethal doses with a high degree of accuracy. Later the constants of toxicity may be redetermined more accurately by some better method just as physical and chemical constants have been continually improved.

If it is assumed that the average susceptibility of the silkworm to acid lead arsenate did not change during the two summers it was used as a standard, the combined results of the writer on this compound can be used to plot a dosage-mortality curve (Fig. 37) nearly meeting Trevan's

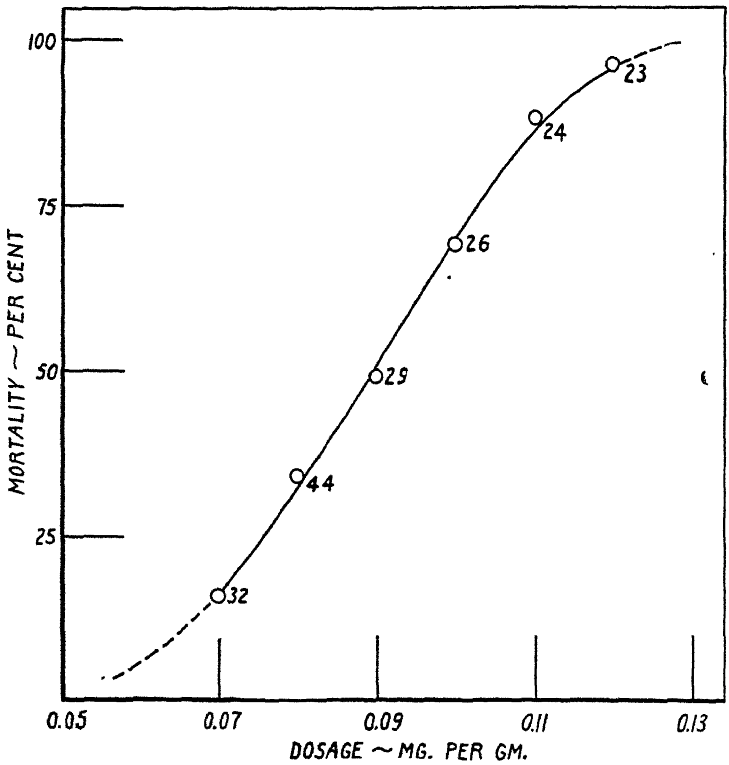


FIG. 37.—The relation of the percentage of mortality of fourth-instar silkworms to the dose of acid lead arsenate.

requirements. The figure beside each point represents the number of larvae used to determine that point. The dose of acid lead arsenate that should kill 50 per cent of a large number of fourth-instar silkworms is 0.090 mg. per gram, confirming the earlier estimate of Campbell and Filmer (2) from more limited data.

The Sandwich Method for the Determination of the Relation Between Dosage and Speed of Toxic Action

In the determination of median lethal doses, the time elapsing between the taking of the dose and the death or complete recovery of

individual insects is not taken into consideration. One is interested only in ultimate death or recovery. The median lethal dose therefore does not tell the whole story of toxicity. Perhaps the most nearly complete picture of the acute toxicity of a compound would be obtained by plotting the reciprocal of the recovery period and of the survival period against doses covering as wide a range as possible. One would get a graph resembling the cross section of a valley, one side representing the effect of sublethal doses, the other side representing the effect of lethal doses, and the bottom of the valley representing the region of the median lethal dose. The sandwich method will provide data for such a graph if the recovery period or the survival period of each poisoned insect is determined. For the present comparison of the toxicity of acid lead arsenate and sodium fluosilicate the effects of lethal doses only were studied.

Since it was necessary to have as many as 80 poisoned larvae under constant observation, the larvae had to be exposed to room temperatures from the time they took their doses until they died. In order to obviate the effect of variable temperatures as far as possible, the two compounds were compared in parallel and the work was done only on hot days when the temperature ranged from 28° to 32° C.

Preliminary experiments[2] in 1928 indicated that more than one end-point would be useful for comparing the effect of the two compounds. In the experiments of 1929, herein recorded, two end-points were determined for each poisoned larva: the "knock-out" point, i.e., the time at which a larva failed to regain its feet after being pushed over, and the death point, i.e., the time at which the last feeble response to touch failed. The time that elapsed from the taking of the dose to the knock-out point and to the death point are here called the active period and the survival period, respectively. The reciprocal of the active period is plotted against dosage in Figure 38, and the reciprocal of the survival period is plotted against dosage in Figure 39. Each circle in both figures represents an observation on an individual insect. When two or more circles happened to coincide, they were scattered enough to make each one visible in order to show the total number of observations. Such changes of position were well within the experimental error. The end-points may have been in error from as much as 5 minutes in the shortest periods to as much as 60 minutes in the longest periods.

[2]In these experiments the writer was assisted by Mr. R. S. Filmer; in later experiments, by Miss Abby Holdridge.

Figure 38 shows that the speed of toxic action of sodium fluosilicate, in terms of the reciprocal of the active period, becomes greater than that of acid lead arsenate as the dosage increases. Figure 39 shows that the speed of toxic action of the fluosilicate, in terms of the reciprocal of the survival period, is less than that of the arsenate at the lower doses and becomes equal to and greater than that of the arsenate as the dosage increases. Together, the two figures show that the silk-

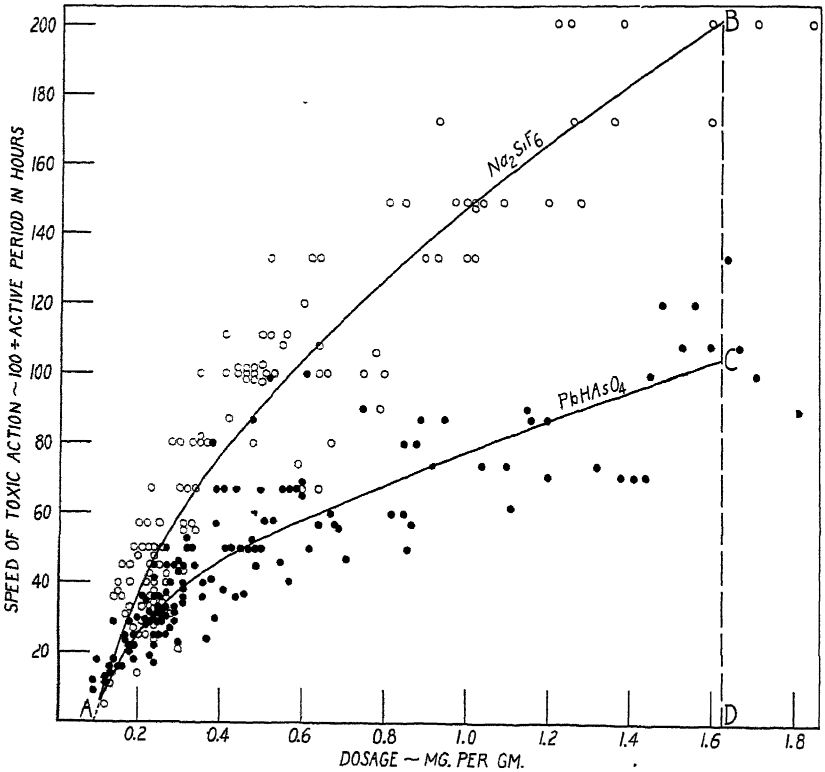


FIG. 38.—The relation of dosage of acid lead arsenate and of sodium fluosilicate to the reciprocal of the active period in the silkworm of the fourth instar.

worm is incapacitated more quickly by the fluosilicate, but that death usually results first from the arsenate at lower doses. This difference follows from the fact that all parts of the body of the silkworm poisoned with the arsenate die at about the same rate, whereas the posterior end of the body of the silkworm poisoned with the fluosilicate may show signs of life much longer than the rest of the body. An explanation was suggested by observations on the effect of these two compounds on the

heart beat of the silkworm. The arsenate has so little effect on the heart that it is usually still beating feebly when the insect is called dead; the fluosilicate stops the beating of the heart long before the insect is incapacitated. The distribution of the arsenate throughout the body of the insect should therefore be more uniform than that of the fluosilicate and should result in a more uniform death rate of the different parts of the body.

How can relative toxicity be measured from Figures 38 and 39? If the ratio of the speeds of toxic action of the two compounds at any

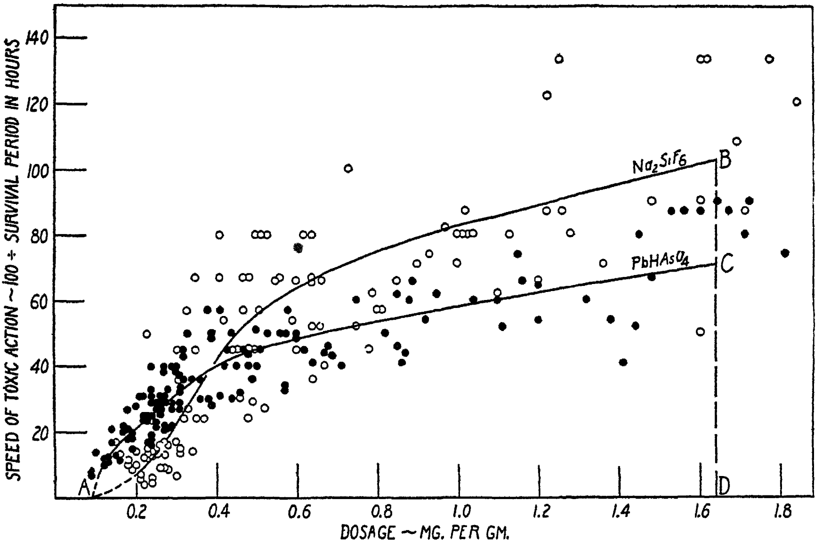


FIG. 39.—The relation of dosage of acid lead arsenate and of sodium fluosilicate to the reciprocal of the survival period in the silkworm of the fourth instar.

particular dose is taken as a measure of relative toxicity, it will be found that acid lead arsenate is more toxic than sodium fluosilicate or vice versa, depending on the choice of end-point or of dose. It is preferable to get a ratio representing relative toxicity over the whole dosage range. As pointed out by Campbell (*1, p. 732*), this can be done by summing up the speeds of toxic action over the whole dosage range and by taking a ratio of the sums. The summation was accomplished by measuring the areas ABD and ACD (Figs. 38 and 39) by a planimeter. The ratios of these areas indicate that the fluosilicate is about 1.8 times

as toxic as the arsenate in Figure 38, and about 1.3 times as toxic as the arsenate in Figure 39.

Although the shape and position of the curve for the fluosilicate in Figure 39 are very uncertain, there can be no doubt that the knock-out point actually leads to a larger ratio than the death point. In other words, relative toxicity here depends on the choice of end-point. Since larvae that reach the knock-out point either from the arsenate or from the fluosilicate are sure to die, and since at that point they may be considered dead in an economic sense because they can no longer eat, the knock-out point is just as practical as the death point and is preferable to it because the knock-out point can be determined more accurately and in less time than the death point.

The Simple Cage Test

Some entomologists believe that if two stomach-poisons are sprayed or dusted as equally as possible on plants and if insects are allowed to feed freely on them, it is possible to determine the relative toxicity of the two compounds. In the present application of the cage test mulberry leaves were sprayed with acid lead arsenate and with sodium fluosilicate, both at 2 pounds to 50 gallons of water. After the leaves had dried, silkworms of the fourth instar were allowed to feed freely on them. Mulberry leaves were also dusted heavily with the same compounds and fourth-instar silkworms were allowed to eat as much as they could. The effects of the spray and of the dust were compared in parallel and the comparison was repeated once. The period in which there was a 50 per cent mortality of each group of larvae was determined. For example, in a group of 40 larvae the survival period of the 20th worm to die was recorded.

The results are shown in Table 2. Although the quantity of the arsenate per unit area of leaf surface was much greater as a dust than as a spray, the period in which 50 per cent mortality occurred was about the same for the dust and for the spray. Perhaps the average quantity of the arsenate consumed was almost independent of the concentration of the poison on the leaf surface. The quantity of the fluosilicate per unit area of leaf surface was also greater as a dust than as a spray, but in this case the different average periods of 50 per cent mortality showed that the insects consumed more of the dust than of the spray, or, in other words, that the quantity of the fluosilicate that is consumed is a function of its concentration on the leaf surface. As a result, the toxicity of the fluosilicate appears to be about half that of the arsenate at a low

concentration on the foliage and about twice that of the arsenate at a high concentration on the foliage.

TABLE 2. THE EFFECT OF THE FOURTH-INSTAR SILKWORM OF ACID LEAD ARSENATE AND SODIUM FLUOSILICATE SPRAYED AND DUSTED ON MULBERRY LEAVES

Application	Number of Larvae	Period of 50 Per cent Mortality: Acid Lead Arsenate	Period of 50 Per cent Mortality: Sodium Fluosilicate	Relative Effect: Speed of Toxic Action of Na_2SiF_6 ÷ That of $PbHAsO_4$
		Min.	*Min.*	
Spray........	40	165	300	0.5
	30	185	345	0.5
Dust.........	22	165	90	1.8
	36	215	100	2.2

THE METHOD OF MARCOVITCH

Ten mature larvae of *Culex pipiens* L.[3] were placed in 50 c.c. of water in each of eight 100-cc. beakers. The beakers were set in a water bath at 27.6±0.1° C. Four quantities of acid lead arsenate and of sodium fluosilicate, 0.025, 0.050, 0.075, and 0.100 gram, were weighed out on glass slides and were added rapidly to the beakers and stirred. Each of the four quantities of the fluosilicate was completely soluble in 50 cc. of water. The time was recorded at which the fifth larva in each beaker failed to respond by wriggling to gentle prodding with the stirring rod. This set of experiments was repeated six times in the course of a week. The results are shown in Table 3.

TABLE 3. THE EFFECT OF ACID LEAD ARSENATE AND SODIUM FLUOSILICATE ON MATURE LARVAE OF *Culex pipiens* L. BY THE METHOD OF MARCOVITCH

Quantity of Poison in 50 c.c. of Water	Acid Lead Arsenate		Sodium Fluosilicate		Relative Effect: Speed of Toxic Action of Na_2SiF_6 ÷ That of $PbHAsO_4$
	Mean Period 50 Per cent Mortality	Standard Deviation	Mean Period 50 Per cent Mortality	Standard Deviation	
Gm.	*Min.*	*Min.*	*Min.*	*Min.*	
0.025	124	18	196	31	0.6
0.050	139	30	123	11	1.1
0.075	124	16	99	18	1.3
0.100	137	22	77	5	1.8

The mean period of 50 per cent mortality is independent of the quantity of the arsenate used but is dependent on the quantity of the fluosilicate. This is brought out more clearly in Figure 40, which shows that the speed of toxic action of the arsenate is constant over the range

[3]The writer is indebted to Mr. C. T. Greene of the U. S. Bureau of Entomology for identifying the species.

of quantities used, whereas the speed of toxic action of the fluosilicate is directly proportional to the concentration over the same range. It is easy to understand this difference. The arsenate, being practically

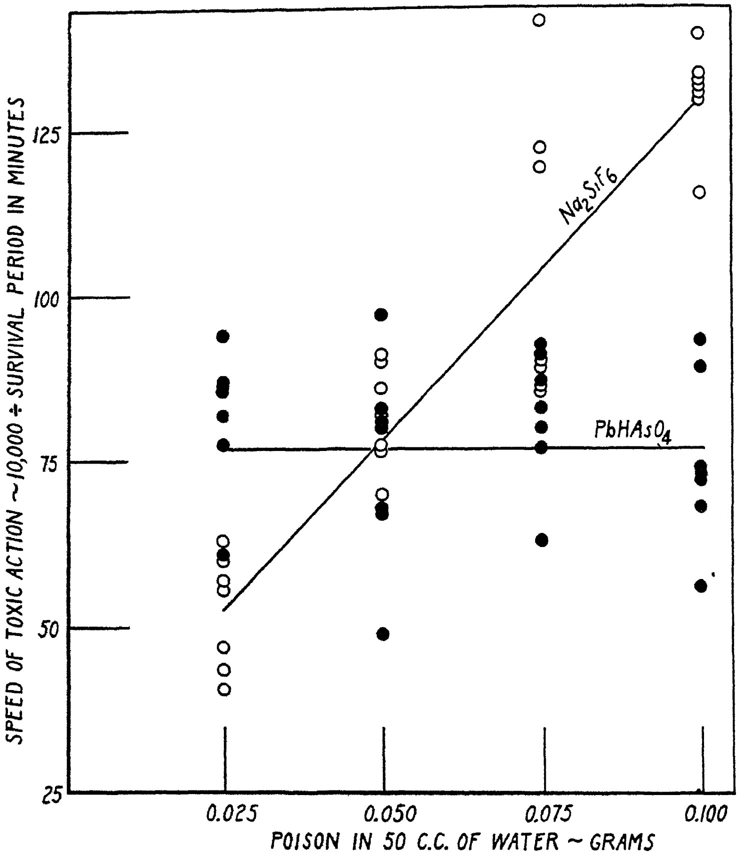


FIG. 40.—The relation of the quantities of acid lead arsenate and of sodium fluosilicate, to which mosquito larvae were exposed, to their speed of toxic action in mature larvae of *Culex pipiens* L.

insoluble, settled to the bottom of the beakers where even the least of the four quantities used was much larger than the maximum quantity that the larvae could consume. Since the arsenate was equally accessible to the larvae in each beaker, about the same mean dose must have been taken in each beaker, resulting in the same mean period of

50 per cent mortality. The fluosilicate, being completely soluble, affected the larvae in proportion to its concentration, as all soluble poisons do when larvae are immersed in their solutions. As a result the fluosilicate appears to be from 0.6 to 1.8 times as toxic as the arsenate, depending on the quantities of the poisons compared.

Discussion

In the last three methods herein studied the relative toxicity of acid lead arsenate and sodium fluosilicate was expressed as a ratio of speeds of toxic action. This is a legitimate way of expressing relative toxicity only if the speeds of toxic action are the result of equal mean doses. For example, if the mean dose of compound A is ½ that of compound B and if the speeds of toxic action are the same, it would not be logical to say that A and B are equally toxic. Obviously A is more toxic than B, because a smaller quantity of A produces the same effect as a larger quantity of B.

In the last two methods the mean doses taken are unknown. Workers who have used these methods for determining relative toxicity may have assumed that mean doses of different compounds, although unknown, are equal. It is probable, however, that the mean doses of the arsenate and the fluosilicate in the last two methods are not equal, because in both methods the mean period of 50 per cent mortality appears to be independent of the quantity of the arsenate offered to the larvae but dependent on the quantity of the fluosilicate. In other words, the relative consumption of the compounds by the larvae seems to change as the quantities of the compounds offered to the larvae are increased. Since the mean quantities consumed are unknown, one does not know which, if any, of the quantities offered lead to the consumption of equal mean doses. The greater the difference in the toxicity of the compounds being tested, the greater should be the difference in the mean quantities consumed and the larger the error in the estimation of relative toxicity.

For reasons just given, the cage test, the method of Marcovitch, and any other method in which insects feed freely and consume unknown quantities of poisons are unsuitable for the quantitative determination of the relative toxicity of stomach-poison insecticides. Such methods, however, may be useful for preliminary estimations of the relative effectiveness of stomach poisons. The method of Marcovitch will now be examined as a measure of the relative effectiveness of stomach poisons.

As a result of a single experiment Marcovitch (*3. p. 33*) found sodium fluosilicate six times as effective as acid lead arsenate against *Culex quinquefasciatus* Say. On repeating this experiment Marcovitch and Stanley (*4, p. 6*) found the former 5.6 times as effective as the latter. In both experiments saturated or nearly saturated solutions of the fluosilicate were used. Consequently the maximum difference in effectiveness between the two compounds was obtained. The ratios found by the writer (Table 3) were much smaller, partly because saturated solutions of the fluosilicate were not used, but largely because *C. pipiens* was more susceptible to the arsenate than *C. quinquefasciatus*, or because the former ate more of that poison than the latter, or for both reasons.

The susceptibility of *C. pipiens* to the fluosilicate was found to be influenced by the environment in which the larvae developed. The results given in Table 3 were obtained with larvae taken from jars to which the dried blood was added several weeks before the period of the experiments. Larvae that were taken from jars to which the dried blood was added a few days before the period of the experiments were much more susceptible to the fluosilicate, 50 per cent of the larvae being killed by all four concentrations in from 40 to 45 minutes. Their susceptibility to the arsenate, however, was practically unchanged. Suspecting that the difference in results might have been due to the presence of more than one species of mosquito larva, the writer took samples of larvae from the jars to Mr. C. T. Greene, who found all of them to be *C. pipiens*.

Since the method of Marcovitch may yield widely different results, depending on the quantities of poisons compared and on the species of larva and its environment, and since such results do not necessarily apply to the insects against which stomach poisons are ordinarily used, it seems to the writer that the simple cage test with appropriate insects is a better method for estimating the relative effectiveness of stomach poisons than the method of Marcovitch.

It has been shown that neither the cage test nor the method of Marcovitch measures the relative toxicity of stomach poisons. The sandwich methods are also open to criticism because they give no information on the relative parts of doses that actually cause death. For example, if equal doses of compounds A and B are consumed and their effects are the same, it may be argued that their toxicities are identical only if equal fractions of the doses enter the tissues and take part in the reactions leading to death. If one-tenth of the dose of A and one-half of the same dose of B enter the tissues and produce the same

effect, A might be considered more toxic than B. If one takes this point of view, none of the methods herein studied measures the relative toxicity of stomach poisons. The writer does not believe, however, that this is the only possible point of view.

The speed of toxic action of a stomach-poison is determined by the rate of the whole chain of physical and chemical events occurring from the time the poison enters the stomach until the insect dies, and the rate of the chain of events is dependent on the size of the dose and not on some fraction of the dose that may be supposed to be directly responsible for the death of the insect. If therefore equal doses of A and B produce the same effect, it seems logical to call them equally toxic *as stomach poisons*. Their relative toxicity by injection may be entirely different.

The first point of view is based on a conception of absolute toxicity, the value of which should be independent of the path of administration of the poison. Unfortunately absolute toxicity can not be measured. In the second point of view the power of the poison to reach susceptible tissues is considered a part of its potential toxicity under particular conditions. Thus it would not be inconsistent to find that the relative toxicity of poisons taken by mouth is different from that by injection.

If it is granted that the sandwich methods measure relative toxicity, which of the two is more suitable for a general survey of the relative toxicity of stomach poisons? The sandwich method for the determination of median lethal doses, being more practicable, is undoubtedly the better of the two. Median lethal doses can be used to compare the susceptibility of mammals and insects to the same stomach poisons and to estimate the least doses that would be required to kill any insect of a given weight. The sandwich method, however, is far from perfect for the determination of the relative toxicity of stomach poisons. It is seasonal and laborious. The ideal method would make possible a rapid oral administration of predetermined doses to an insect available throughout the year.

Conclusions

The toxicity of sodium fluosilicate to the fourth-instar silkworm ranges from 1 to 2 times that of acid lead arsenate, depending on the criterion of toxicity. Sodium fluosilicate incapacitates the silkworm faster than does acid lead arsenate, but the latter may kill the whole larva more rapidly than the former.

Methods in which insects are permitted to consume freely unknown quantities of poisons are unsuitable for the determination of the relative

toxicity of stomach-poisons because the observed effects, being usually produced by unequal mean doses, are not comparable. The sandwich method for the estimation of median lethal doses is the most practicable quantitative method so far proposed. Although the reliability and general significance of its results are satisfactory, it should be replaced by a less laborious method permitting the rapid oral administration of predetermined doses to an insect available throughout the year.

Literature Cited

1. Campbell, F. L. 1926. Relative susceptibility to arsenic in successive instars of the silkworm. Jour. Gen. Physiol. 9:727–733.
2. Campbell, F. L., and Filmer, R. S. 1929. A quantitative method of estimating the relative toxicity of stomach-poison insecticides. Trans. IV. Internatl. Cong. Ent. 523–533.
3. Marcovitch, S. 1928. Studies on toxicity of fluorine compounds. Univ. Tenn. Agr. Expt. Sta. Bul. 139, 48 p.
4. Marcovitch, S., and Stanley, W. W. 1929. Cryolite and barium fluosilicate: their use as insecticides. Univ. Tenn. Agr. Expt. Sta. Bul. 140, 19 p.
5. Trevan, J. W. 1927. The error of determination of toxicity. Roy. Soc. [London] Proc. (B) 101:483–514.

President T. J. Headlee: The next paper is by S. Marcovitch and W. W. Stanley.

TWO ARSENICAL SUBSTITUTES

By S. Marcovitch and W. W. Stanley, *Agricultural Experiment Station, Knoxville, Tennessee*

Abstract

Among the fluorine compounds, cryolite and barium fluosilicate offer the most promise at the present time of meeting the requirements of an arsenical substitute. They are highly toxic to insects and reasonably safe on foliage. Barium fluosilicate is somewhat more toxic to insects than cryolite, and both materials when used at the rate of one pound to 50 gallons of water gave excellent control of the bean beetle. These materials may also be used as a dust on tobacco for the tobacco hornworm and flea beetles, and on beans for the bean beetle. Fish oil materially aids the sticking qualities of both cryolite and barium fluosilicate.

The need for an arsenical substitute is now clearly recognized by fruit and truck growers. Among the many fluorine compounds tested, both cryolite and barium fluosilicate appear to meet the requirements of toxicity, freedom from foliage injury, and availability.

Properties and Reactions

CRYOLITE. Cryolite occurs as a native fluoride of aluminum and sodium in Greenland. More than 10,000 tons are shipped annually for use in the manufacture of aluminum, the fused mineral being used as the bath for the electrolysis of alumina to the metal. Cryolite is also used in the manufacture of opaque white glass, in the enameling of ironware, and as a flux in the manufacture of white Portland cement. The natural cryolite when ground is a heavy powder and not well adapted for insecticidal purposes.

A synthetic powdered form is now available in commercial quantities that is light, very uniform in composition, and with a solubility of one gram to 1,639 parts of water. In water the artificial cryolite gave a pH of 6.2. One gram of the material required only 1½ c.c. 1/10 N. NaOH for neutralization, showing a very small soluble acid content.

The average analysis of the synthetic cryolite as submitted by Jungmann and Co. is as follows:

Sodium aluminum fluoride	98.20	per cent
Silica	.74	"
Sodium sulphate	.36	"
Iron oxide	.06	"
Moisture	.64	"

Several methods are known for making artificial cryolite—$Al_2F_6.6NaF$. Howard[1] used aluminum fluoride, ammonium fluoride, and salt, in accordance with the following reactions:

$$Al_2F_6 + 6NH_4F + 6NaCl = Al_2F_6.6NaF + 6NH_4Cl$$

Cryolite is readily decomposed by acids and alkalies. With lime, sodium aluminate and calcium fluoride is formed, as follows:

$$Al_2F_6.6NaF + 6Ca(OH)_2 = 3Na_2O.Al_2O_3 + 6CaF_2 + 6H_2O$$

BARIUM FLUOSILICATE. Barium fluosilicate is not a commercial chemical at present, but due to its promising insecticidal properties several manufacturers have expressed a willingness to supply any demand that may arise. The principal virtue of barium fluosilicate lies in its low solubility (1–3750) and consequent freedom from excessive foliage injury. A saturated solution shows a pH of 3.4. One gram of material will require 110 c.c. of 1/10 N NaOH for neutralization.

[1]Howard H. Process of Making Artificial Cryolite. U. S. Patent No. 1,471,555.

In general, barium fluosilicate will react like sodium fluosilicate, but at a slower rate of speed. Barium fluosilicate may be made from by-product fluosilicic acid or from sodium fluosilicate, both of which are abundant and cheap. At the present writing barium fluosilicate is quoted at the same price as lead arsenate. If the demand for barium fluosilicate should increase, large-scale production would undoubtedly effect economies in manufacture.

The Question of Toxicity

Melanoplus femur-rubrum was employed to determine comparative toxic values. One gram of the chemical was used with 50 grams of bran. Within 30 hours, sodium fluosilicate gave 100 per cent mortality; barium fluosilicate 95 per cent; cryolite 20 per cent, and magnesium arsenate none.

Tests with other insects point unmistakably to barium fluosilicate as being much more toxic than cryolite when used against full-grown insects. One would be led to believe that correspondingly better results would be obtained in large-scale field tests against the bean beetle. The experimental work revealed little difference between barium fluosilicate and cryolite when used as a spray at the rate of one pound to 50 gallons of water for the bean beetle.

In small-scale experimental tests, differences in toxicity largely disappear as the dosage is increased. In the field, much more poison is used than is usually necessary, so that results do not vary as much as in the laboratory.

The poisoning operations with the bean beetle are conducted against the very small larvae, often not more than a day or two old. The young stages of insects are more easily killed and require much smaller amounts of poison than mature forms. In either case the large-scale operations to obtain practical control provide more material than will barely kill the insects. With the arsenicals an analogous situation exists. Paris green is known to be much more toxic than lead arsenate, yet the latter will give better control because of other factors, such as density and adhesiveness.

In the determination of the value of an insecticide several factors must be considered, among them being dosage, adhesiveness, toxicity, the nature of the insect employed, and freedom from foliage injury.

Effect on Foliage

The causes of foliage injury by chemicals are among the least-known phenomena in spraying and dusting plants. In general, materials that are readily soluble in water are more apt to burn. Sodium fluosilicate,

with a solubility of 1–154, is more likely to burn than calcium fluoride, with a solubility of 1–25,000. On the other hand, a highly insoluble material shows poor toxicity. For best results a material should be sufficiently soluble in the digestive tract of the insect to kill, and yet not injure foliage. The margin of safety is so small that among the host of chemicals known, only a few come near meeting the requirements. The work to date indicates that cryolite, with a solubility of 1-1,639, and barium fluosilicate, with a solubility of 1–3,750, falls within the safety zone. The past summer's work with these materials when used at the rate of one pound to 50 gallons of water on bean foliage revealed not a single instance of burning. Used as a pure dust at the rate of 6 to 12 pounds per acre, these materials were likewise safe on beans. When they were used in amounts greater than 20 pounds per acre some foliage injury was observed on beans. Since excellent control was obtained with only six pounds of pure dust per acre, the larger amounts are wasteful. If a machine is not available for dusting small amounts per acre, these materials may be mixed with a dilutent, such as lime or fuller's earth.

Different plants vary in their susceptibility to burning by fluorine compounds. Cotton seems to be the most resistant, followed by beans, cabbage, apple, potatoes, tobacco, cucumbers, peanuts, peach, and smartweed. No injury was observed from five weekly dustings on tobacco with either cryolite or barium fluosilicate when used at the rate of six to ten pounds to the acre. A few peach trees were sprayed with these materials at the rate of one pound to 50 gallons of water. Six weekly applications showed no visible foliage injury.

Fish oil, now used with lead arsenate as a sticker, was also found to be a very decided aid to the adherence of cryolite or barium fluosilicate. No foliage injury was noticed from it except when the insecticides were were used in amounts larger than were necessary.

Field Tests Against the Mexican Bean Beetle

Magnesium arsenate, calcium arsenate, cryolite, and barium fluosilicate were used at the rate of one pound to 50 gallons of water on 1/40-acre plots. Beginning May 17, five sprays were applied. All of these materials gave excellent control. Neither cryolite nor barium fluosilicate produced any burning whatsoever. The May 27th spray of calcium arsenate, however, caused considerable foliage injury, while a similar type of injury was encountered later in the season with magnesium arsenate. Our observations showed that this arsenical injury usually took place when the spray was applied just before the beans began to blossom.

Counts were made of the larvae present on June 15. The sprayed plots showed an average of 15 larvae per 3 feet of row, while the checks had 72 larvae. The sprayed rows yielded 10 pounds of green beans to the row, while the untreated rows yielded 6½ pounds.

The insecticides applied in the dust form also gave good control. The chief difficulty encountered was in getting the dusts on the underside of the leaves. All of these experiments were repeated on a large plot of beans nearly two acres in size. Substantially the same results were obtained. Space does not admit of our giving all the details, which will be published elsewhere. The best control among the dusts was obtained with barium fluosilicate when used pure at the rate of six pounds to the acre.

With a power sprayer, the cost of spraying an acre of beans runs between $1.30 and $1.75 for one application. With a bucket pump or a small three-gallon compressed-air sprayer, the cost approximates $2.40 when standard insecticide materials are used. Dusts applied with a rotary hand duster cost $1.50 per acre. Usually three sprays or four dust applications are necessary to give good control.

Experiments for the Control of the Tobacco Hornworm

The usual recommendations for the control of the tobacco hornworm (*Protoparce sexta*) consist of dusting with lead arsenate at the rate of five pounds per acre. Since tobacco growers are showing an interest in an arsenical substitute on tobacco, we gave both cryolite and barium fluosilicate a trial. We used cryolite, barium fluosilicate and potassium fluosilicate alongside of lead arsenate in four different plots. From the check plot we picked off 116 worms, from lead arsenate 5, cryolite 2, barium fluosilicate 8, and potassium fluosilicate 15. The potassium fluosilicate was lumpy and did not dust well. All of these materials gave good control and no foliage injury when used at the rate of six pounds per acre. Seven applications were made in order to test for foliage injury (Table 1).

Table 1. Tests of Insecticides Against the Tobacco Hornworm

(*Protoparce quinquemaculata*)

Material Used	Rate of Application	Date of Application	Degree of Infestation No. of Larvae	Foliage Injury
Lead arsenate	6 lbs. per acre	July 6–13–20–26– Aug. 2–9–16	5	None
Cryolite.......... .	"	"	2	"
Barium fluosilicate...	"	"	8	"
Potassium fluosilicate (by-product)......	"	"	15	"
Check..............			116	

The Tobacco Flea Beetle

One of the most troublesome insects in the tobacco bed is the tobacco flea beetle (*Epitrix cucumeris*), because of its potentialities in carrying diseases. These tiny pests are difficult to control, since the arsenicals are not readily eaten. In order to keep them in subjection Paris green must be resorted to, mixed with arsenate of lead.

Since flea beetles have the habit of licking their feet and cleaning themselves, and as sodium fluosilicate was found especially effective against insects with these habits, we made tests with cryolite and barium fluosilicate. In cage tests barium fluosilicate killed 92 per cent within 24 hours, while cryolite killed 77 per cent and lead arsenate 23 per cent (Table 2). A single application of barium fluosilicate in the field was observed to give a very material reduction in the number found on the plants. Since cryolite and barium fluosilicate will also control the hornworm, these materials show marked promise as tobacco insecticides.

TABLE 2. CAGE TESTS OF INSECTICIDES USED AS DUSTS AGAINST THE TOBACCO FLEA BEETLE, *Epitrix cucumeris*, SHOWING PER CENT DEAD IN HOURS

Material	16 hrs.	24 hrs.	48 hrs.	72 hrs.	96 hrs.
Barium fluosilicate	87	92.4	96	100	100
Cryolite	58	77	86	96	97
Lead arsenate	14	23	36	48	60
TESTS WITH THE CUCUMBER BEETLE, *Diabrotica vittata*					
Barium fluosilicate	80	100			
Cryolite	26	52			
Lead arsenate	19	35			

The Cucumber Beetle

Cage tests with the cucumber beetle (*Diabrotica vittata*) showed 100 per cent mortality with barium fluosilicate in 24 hours; cryolite gave 52 per cent, and lead arsenate 35 per cent. No foliage injury was obtained with these materials when used lightly at the rate of six pounds to the acre.

Mr. M. V. Anthony carried out the experimental work on tobacco insects, and assisted in the spraying and dusting experiments for the bean beetle.

Summary

The demand for an arsenical substitute has arisen from various sources, such as the truck and apple growers, who are harassed with the residue problem. Muck soils will decompose the insoluble arsenates, making the ground unfit for growing plants.

Among the fluorine compounds which best meet the requirements of a stomach poison, cryolite and barium fluosilicate offer the most promise at the present time.

These materials have a comparatively low solubility, and are therefore reasonably safe on foliage. They may now be obtained in commercial quantities at about the same price as lead arsenate.

Both cryolite and barium fluosilicate are highly toxic to insects. In small quantities, such as might occur on plants, fluorine compounds, as far as known, are not dangerously poisonous to man.

For adult insects, barium fluosilicate is more toxic than cryolite. Both materials gave excellent control of the Mexican bean beetle when used as a spray at the rate of one pound to 50 gallons of water.

At the rate of six pounds to the acre, both cryolite and barium fluosilicate used as a dust gave no foliage injury on beans. Thirty pounds or more to the acre produced moderate burning. Five weekly dustings on tobacco produced no foliage injury with either material, and controlled the hornworms and flea beetles.

Fish oil used at the rate of 25 per cent of the weight of cryolite, or barium fluosilicate very decidedly aided the sticking qualities.

Both cryolite and barium fluosilicate, used in the dust form, at the rate of six pounds to the acre, gave very good control of the bean beetle. These materials were also used successfully when mixed with two parts of lime.

Mr. W. E. Hinds: I should like to ask if any tests were made on corn.

Mr. W. W. Stanley: We tried several tests on corn this summer. We used both cryolite and barium fluosilicate to determine what degree of control might be found on the corn earworm. Both chemicals caused slight burning to the tassels, but no appreciable injury to the foliage. Barium fluosilicate gave somewhat more injury.

President T. J. Headlee: Next is a paper by Ralph H. Smith.

A BRIEF REPORT ON THE TANK-MIXTURE METHOD OF USING OIL SPRAY

By Ralph H. Smith, *Associate Entomologist, University of California, Citrus Experiment Station*

Abstract

With over 35 brands of highly refined oil emulsions on the market for use in the spraying of citrus trees in southern California, backed in general by methods of "high-pressure" salesmanship, and with widely variable results in insect control and injury to trees, a definite need existed for a formula whereby the grower who so desired could use a spray of known composition. Pursuant to this need investigations showed that, when the type of oil best suited for citrus spraying is used, the principal quality of the spray mixture is that which relates to the quantity of oil deposited and the uniformity of the oil coverage. Tests showed that it is entirely

practicable, with modern orchard sprayers, to maintain a uniform mixture of water, emulsifier, and pure oil, added separately to the spray tank, by using large-sized blades on the agitators and increasing the speed of the agitator shaft to about 225 r.p.m. By dyeing the spray oil and placing a piece of heavy-walled glass tubing at each end of the spray hose, one between the spray tank and the hose and the other between the hose and the spray nozzle, the fact was determined that the oil globules do not coalesce or float out to any material extent in passing through the spray hose. Microscopic studies of samples taken from the spray tank and from the spray nozzle showed that even though globules of relatively large size might pass through the hose, these are broken into very small globules, quite comparable to those in proprietary emulsions, as a result of being forced through the nozzle under a pressure of 300 pounds.

Studies on the quantity of oil deposited on glass and citrus leaves, 25 square inches being used as the unit of area, showed that certain proprietary emulsions deposited three times as much oil as others. The average amount deposited on the glass was 21 milligrams. Tests with the tank mixture, using calcium caseinate spreader at the rate of ½ pound to 100 gallons of water, showed a deposit of 22 milligrams of oil. All tests were made with two percent of actual oil in the spray.

Introduction

The term "tank mixture" is applied to the method of using oil spray in which the water, emulsifier and pure oil are added separately to the spray tank and a uniform mixture maintained by the agitators. The method has been used for nearly four years at the Citrus Experiment Station in experimental tests in comparison with several of the leading proprietary emulsions, and in regular control work on the Station property. In addition, during the past two years, it has received practical testing by growers in spraying over 300 acres of citrus trees. It appears to have an important place in the spraying of citrus trees under the conditions of pest control occurring at the present time in southern California. Whether or not it is applicable to the dormant and summer applications of oil sprays to deciduous trees, or merits recommendation for general use, remains to be determined.

The method was originally used in experimental tests to determine the value of different kinds of spray oils. The results obtained by using the oils in this manner were more dependable, it was believed, than if the oils were emulsified before adding them to the spray tank. The latter procedure carried the possibility of variable results being caused by differences among batches of emulsions. Furthermore, in many tests it was desired to entirely dispense with the use of emulsifiers. Subsequent observations on the widely variable results in insect control and injury to trees, which was especially apparent in 1928 when over 35 different brands of proprietary oil sprays were on the market, led to the investigation and results briefly reported herein.

The insecticidal efficacy of oil sprays and the effects of oil sprays on trees, insofar as the oil is concerned, are governed by (1) the purity of the oil, (2) the viscosity and volatility of the oil, and (3) the quantity of oil deposited on the insect and tree. The first two factors are measurable and quite well understood at the present time.

The third factor is the one with which this paper is chiefly concerned. Its importance is fundamental. The original purpose underlying the discovery of kerosene emulsion 50 years ago was to provide a way to accomplish a uniform coverage of oil over the trees. That apparently is the only reason why spray oils are made into emulsions at the present time.

Spray-tank Agitation. The first requirement for assuring a uniform coverage of oil is that the oil be uniformly distributed through the water in the spray tank. Much emphasis was once placed on the danger of the oil rising to the top of the water, due to improperly-made emulsions and to emulsions "breaking" when mixed with water in the spray tank. However, a study of many sprayers in practical operation and in experimental tests has shown conclusively that it is a simple and entirely practicable matter to maintain a uniform mixture when pure oil is poured into the water in the tank.[1] A brief statement of the essential facts will be sufficient here.[2]

In the case of the Bean, Deming, Hardie, Hayes, Karth, Mount Gilead, and Ward-Love sprayers, the agitator shaft is approximately 7½ inches from the bottom of the tank. Waiving discussion of minor factors it may be said that if the agitators, whether two-bladed or three-bladed, have blades approximately 6½ inches long and 4½ inches wide with a pitch of 40 degrees, and are placed approximately six inches from the ends of the tank and one foot apart on the agitator shaft, and the latter has a speed of 225 r.p.m., a uniform mixture of pure oil and water can be maintained in any tank of ordinary form, either half-round or elliptical, up to 400 gallons in capacity. Thus equipped, the tank may be filled with water, pure spray oil then poured on the top, and after the agitator has run for two minutes (tests have not been made

[1]The mixture of pure oil and water is discussed because this represents the most adverse condition, as pertains to agitation, that would be confronted in practical spraying. As shown in the articles on spray-tank agitation, cited in the accompanying footnote, the addition of a spreader or emulsifier, as is required in the tank-mixture method, greatly facilitates the ease with which a uniform mixture can be maintained.

[2]For further information concerning agitation in spray tanks, see Jour. Econ. Entom. December, 1929, pp. 929–934.

to determine the minimum time) the oil will be uniformly dispersed in small globules throughout the water.

One test with a "Friend" sprayer, which has a type of agitator that is different from the sprayers aforementioned, will be described. The data concerning the sprayer are as follows: Capacity of tank 300 gallons, speed of agitator shaft 200 r.p.m., blade of front agitator 9 inches long and 6 inches wide, blade of rear agitator 8½ inches long and 3 inches wide. The tank was filled with water and three gallons of oil poured on the surface. The agitator was then started and at the end of fifteen seconds a uniform mixture was produced.

QUANTITY OF OIL DEPOSITED. The second requirement of an oil spray, as pertains to the uniformity of the coverage of oil, is that the physico-chemical composition of the mixture be such that in case one part of a tree is drenched in spraying and another part is moderately sprayed, the deposit of oil will not be excessive on the one part nor insufficient on the other. The importance of this factor is emphasized by the results of the present study which show that in the case of the oil emulsions generally used in summer spraying, the deposit of oil tends to build up as spray is applied in excess of the amount required to produce the initial film, and that the quantity of oil deposited in the initial film, as well as the building-up tendency, varies greatly among emulsions. Certain experiments bearing on this subject will be briefly discussed.

Thin window glass was cut into sections 3½ inches wide and 7 inches long, the area of one surface being regarded as 25 square inches. An extensive set of tests was made in the laboratory, in which spray was applied by means of an atomizer, under three pounds constant air pressure, to one surface of each section. Four sections were used in each test. By weighing before spraying and after spraying when the water had evaporated, the quantity of oil deposited was determined. This work was supplemented by applying the spray with a spray gun under 300 pounds pressure, with many adaptations designed to bring out the importance of different variables and the factors controlling them. Tank-mixtures with spray oils of different viscosities and with different emulsifiers were tested in comparison with proprietary emulsions. The spray in each test contained two per cent actual oil. The average amount of oil deposited in laboratory tests with 12 different proprietary emulsions[3] was 21 mg. per section. Four emulsions deposited less than 13 mg.

[3]The proprietary emulsions were true emulsions; that is, none was a miscible oil. They contained from 80 to 90 per cent oil. The oils were of the highly-refined type, being above 84 per cent in unsulfonated residue, and ranged from 50 to 100 seconds Saybolt, in viscosity.

per section and five deposited more than 25 mg. The lowest was 11 mg. and the highest 33 mg. The tank-mixture consisting of pure spray oil thoroughly agitated with water containing calcium caseinate spreader at the rate of ½ pound to 100 gallons, deposited 22 mg. The oil used in this test had the same specifications as that contained in a widely used proprietary emulsion, the viscosity being 50 seconds Saybolt and the unsulfonated residue 94 per cent. Tests similarly made with orange leaves showed that considerably more oil per unit of area was deposited on the leaves than on the glass and that the building-up tendency was more pronounced on the leaves. The fact was determined that less oil is deposited on objects close to the spray nozzle than on those several feet away. The intermittent exposure of a surface to the spray, such as results from playing the spray nozzle back and forth, accentuates the building up of the deposit. Spraying a surface for the second time immediately after the water from a previous application has evaporated results in approximately doubling the deposit of oil.

Size of Oil Globules. Considerable attention heretofore has been given to the size of the oil globules in spray emulsions, the supposition being that the quality of the spray is related to the size of the globules. Certain experiments relating to this subject will be of interest.

Pure spray oil ranging above 90 per cent in unsulfonated residue, and different proprietary emulsions containing this kind of oil, were dyed with oil-soluble red dye in order that the globules could be readily observed. A piece of heavy-walled glass tubing was fastened to each end of a 50-foot spray hose, one piece being attached between the hose and the spray tank and the other between the hose and the spray gun. In this manner it was possible to observe the character of the spray mixture during agitation and during passage through the hose. The study also involved taking samples from the tank and from the nozzle in 500 cc cylinders and the studying of microscopic mounts. The tests were made with a 200 gallon tank equipped with four agitators each having two blades 6½ inches long and 4½ inches wide, and turning at 225 r.p.m.

The globules of the tank-mixture, as observed both in the tank and in the glass tubes, were somewhat larger than those of the spray mixture containing the proprietary emulsions but this difference was scarcely distinguishable in samples taken from the spray nozzle under a pressure of 300 pounds. As a result of various modifications in the method of testing, the fact was determined that even though globules of comparatively large size might pass through the hose, these are

broken into very small globules under the effect of the pressure with which they are forced through the nozzle. With a pressure of 300 pounds the largest sized globules from the tank-mixture of pure oil and water were no larger and no more numerous than those from the proprietary emulsions.

KIND AND AMOUNT OF EMULSIFIER. Preliminary tests at once indicated that the most important factors affecting the quantity of oil deposited were the kind of emulsifier and the amount present in the spray. Extensive tests have been made on this phase of the study but because of certain large variations in measurements, resulting apparently from imperfect technique and apparatus, only a few general statements can be made at this time. Soaps cause much less oil to be deposited than do other emulsifiers used in equivalent amounts. In the case of certain emulsifiers, small amounts, two ounces or less per hundred gallons of spray, result in a heavier coating of oil than occurs when no emulsifier is used at all. Certain emulsifiers or spreaders, even when used in amounts which give good spreading with other sprays, may actually result in more oil being deposited than is deposited by a mixture of pure oil and water.

CONCLUSIONS. Taking into consideration (1) the large number of proprietary oil emulsions on the market in southern California and the variable results experienced in injury to trees and insecticidal effectiveness and (2) the experimental data mentioned in this paper which show that, under like conditions, certain emulsions may deposit three times more oil than others, there seems to be ample ground for concluding that a definite need exists for a method whereby the grower who so desires can make his own spray. The investigation, at present, indicates that the tank mixture meets this need better than the formulae heretofore suggested for "home-made" oil sprays. The method is especially suitable under conditions in this region where nearly all of the spraying is done by licensed commercial spray operators, under supervision of County Agricultural Commissioners. The fact that a saving of about 50 per cent of the present cost of emulsions is made possible, is also worthy of consideration.

The author is cognizant of the fact that within the past 10 years authorities on spraying have very generally abandoned home-made formulae in favor of standardized proprietary products. He is in full accord with that tendency. The highly-refined oil emulsions represent an exception, however, in that they are not standardized with regard to the factors discussed in this article. Until they become standardized

to a greater degree than at present, the tank-mixture method may properly have a place in recommendations for the spraying of citrus trees. Should the continuation of this investigation produce further evidence to substantiate the proposition that the making of oils into concentrated emulsions is unnecessary, the reason for the exception will, of course, be further strengthened.

PRESIDENT T. J. HEADLEE: I would like to ask Mr. Smith whether the toxicity of the oils to foliage is dependent upon the amount left upon the foliage more than upon other factors.

MR. R. H. SMITH: In spraying citrus trees in California, we advise using oils that are 90 per cent or above in unsulfonated residue. When injury results from the use of an oil of that purity, such injury is due either to the oil being too heavy, that is, too non-volatile, or to too much oil being deposited by the emulsion. The excessive amount of oil deposited is responsible for many cases of injury.

PRESIDENT T. J. HEADLEE: Our own experience indicates that that position is extremely well taken. The amount of oil deposited, other things being equal, is perhaps the dominant factor.

MR. ANTHONY SPULER: I would like to ask Mr. Smith if the amount deposited does not depend on the length of time the mixture is sprayed on a tree.

MR. R. H. SMITH: I did not have time to discuss the factors relating to the application of the spray, which affect the amount of oil deposited and the tendency of the oil film to build up, but those tests with the spray machine were done in many different ways. We exposed surfaces intermittently to the spray. Other times we would spray, shake the spray off and spray again. In other cases we would spray and let the water evaporate, and spray again.

There are many factors that have to do with the building up of the oil film. I cannot discuss them completely, but will say that in our work we found by using one-half pound of calcium caseinate spreader to 100 gallons of water there was no greater tendency for the tank-mixture to build up than was the case with the best of the proprietary oil emulsions in general use.

PRESIDENT T. J. HEADLEE: The next paper is by A. L. Strand.

A PHASE OF INSECT RESPIRATION IN RELATION TO THE TOXICITY OF CONTACT INSECTICIDES

By A. L. STRAND, *St. Paul, Minn.*

(Withdrawn for publication elsewhere)

MR. W. C. O'KANE: The paper by Mr. Strand, the elaborate and fine work he is doing up there, emphasizes to all of us the extraordinary complexity of many unknown and very valuable factors in economic entomology. If we had 15 or 20 men to work on insect respiration, well trained men, at the present time they would have five or ten years' work ahead of them to find out the things that we as entomologists really ought to know. I wish there were more in the same kind of work.

PRESIDENT T. J. HEADLEE: The next paper is by D. M. DeLong, W. J. Reid, Jr., and M. M. Darley.

THE PLANT AS A FACTOR IN THE ACTION OF BORDEAUX MIXTURE AS AN INSECTICIDE

By D. M. DELONG, W. J. REID, JR., and M. M. DARLEY,[1], *U. S. Bureau of Entomology, Columbus, Ohio*

ABSTRACT

Tests with inverted petri dishes covered with capping membranes and containing sugar solutions or expressed plant juices showed that copper could be dissolved from Bordeaux mixture residues sprayed on the capping membranes. Distilled water, used in the same manner, gave negative results. Rain-water collected over a period of approximately three months and which had passed through glass funnels containing filter papers covered with Bordeaux mixture residue gave negative chemical tests for copper. Rain-water collected from plants sprayed with Bordeaux mixture and leaves containing Bordeaux mixture washed in water gave chemical tests for copper. Rain or dew is not necessary on the Bordeaux mixture sprayed plant in order to kill leafhoppers.

Refractometer readings of sprayed and unsprayed plant juices showed that, as a rule, in vigorous growing plants the solid (sugar) content of the sprayed plants was lowered for about two days below that of the unsprayed plants but soon became higher and with few exceptions usually remained higher than that of the unsprayed plants for about two weeks.

[1]Suggestions, advice and criticisms regarding methods and results have been offered by Dr. N. F. Howard, U. S. Bureau of Entomology, Columbus, Ohio; Dr. Edward Mack, Department of Chemistry, Ohio State University; Dr. R. C. Burrell, Department of Agricultural Chemistry, Ohio State University; and by Drs. B. S. Myers, Lois Lampe, and G. W. Blaydes and Mr. K. E. Wright of the Botany Department, Ohio State University.

Previous work performed by many workers upon Bordeaux mixture as a fungicide or insecticide has shown certain definite facts regarding its use or action which should be stated very briefly as an introduction to the experimental data presented herein. A spray of Bordeaux mixture when dried is practically insoluble in water, and if permitted to settle as a precipitate in a spray solution there is practically no copper in the supernatant fluid (*2*) (*11*). But in order for it to become effective as either a fungicide or an insecticide it apparently must be rendered soluble. The question of how this is accomplished on the plant has been the subject of considerable experimental work and discussion. Previous work, especially by Crandall (*6*), has pointed to atmospheric conditions or meteoric water as the most important agents in rendering copper soluble from a Bordeaux mixture spray film. This conclusion was reached by testing water from sprayed apple trees. On the other hand Clark (*4*) has stated that the epidermis of the leaves, although protected by a cuticle, is well known to be more or less permeable to the dissolved substances occurring in the cell sap, particularly along the union of the epidermal cells. On this basis he explains that the dew on the outside and the cell sap within cause exosmosis to take place and the copper hydroxide to become at least partially soluble.

It is known that sugar solutions will readily dissolve copper from Bordeaux mixture. With this fact as a basis, a series of experiments was performed using petri dishes and covering them with capping membranes (*3*) which were sealed over the open end. Equal volumes of distilled water, tap water, sap expressed from bean plants, and sap expressed from potato plants, as well as solutions of dextrose, sucrose, and other sugars varying from 1 to 15 per cent in strength were placed in individual petri dishes before the membranes were sealed over the top. The membranes were then sprayed with freshly made Bordeaux mixture and permitted to dry. The petri dishes were thereupon inverted so that the solution inside was kept in contact with the Bordeaux mixture covered membranes. In two or three days the membranes were removed and the liquid tested for copper. The distilled and tap water gave negative copper tests, but in every case where sugar was present in the water positive tests were obtained, and the percentage of copper varied directly with the percentage of sugar in the solution. The plant juices of both bean and potato gave strong positive tests showing that the juices of these plants can readily dissolve copper in some form from Bordeaux mixture residue and absorb it through a permeable membrane. A similar condition caused either by sugars or organic acids probably occurs in sprayed plants.

RAIN-WATER TESTS OF BORDEAUX RESIDUE ON FILTER PAPER. In order to test the solubility of Bordeaux mixture under out-of-doors conditions with the plant eliminated as a factor, heavy applications of Bordeaux mixture were made to filter papers placed in glass funnels. The stem ends of these funnels were placed in stoppered glass bottles and these were placed in the open where they would be exposed to the elements. During a period of approximately three months several liters of water were collected from summer rains and dew which passed over the Bordeaux-mixture residue on the filter papers. By testing this water for copper and using a test[2] that would readily show a 1–50,000 solution, all tests were negative or doubtfully positive even when the water was evaporated and the solution rendered more concentrated. This agrees with results obtained by Crandall (*6*) while using glass evaporating dishes and shows rather conclusively that rain-water alone, in appreciable quantities, will not dissolve copper from Bordeaux mixture.

SOLUBILITY OF COPPER FROM BORDEAUX MIXTURE IN RAIN WATER FROM SPRAYED LEAVES. In rain-water collected from plants which were previously sprayed with Bordeaux mixture, soluble copper was detected very readily and a strong positive reaction was obtained from the mixture with potassium ferrocyanide. This same reaction can be obtained by washing the sprayed leaves in distilled or tap water. The reaction in this case has been obtained within two or three days after the plants were treated. Thus copper can be dissolved readily from Bordeaux mixture residue upon plants but can not be dissolved from residues of similar material on other objects or materials. The plant must therefore be recognized as an important factor in the solubility of copper from Bordeaux mixture. Precipitation is apparently not important if we may judge from previous experiments and observations. Leafhoppers will die in a short time upon plants which have been sprayed with Bordeaux mixture and protected from rain and dew. Furthermore, recent tests have given positive copper reactions in plant juices which were expressed from plants sprayed with Bordeaux mixture where the residue was removed by a 2 to 5 per cent acetic solution before the juice was expressed. These plants also were protected from rain or dew, and some factor other than precipitation must have rendered the copper soluble. Plants under exactly the same conditions but not treated gave negative copper tests by the same method. It has been observed (*7*) that death of the feeding leafhopper occurs

[2]Both hydrogen sulphide (H_2S) and potassium ferrocyanide ($K_4\ Fe\ (CN)_6$) were used.

much sooner on the sprayed surface of a leaf than upon the unsprayed surface of the same leaf. Although no method has been devised for obtaining data, it is quite probable that the Bordeaux-mixture residue becomes more soluble at the point where the mouthparts puncture the leaf for feeding. The plant juice is undoubtedly in closer proximity at these points with the residue of Bordeaux mixture, at least in small quantity, and this plant juice has been proved to dissolve copper readily from such residue when in contact with it.

The plant is therefore thought to be an essential factor in rendering copper soluble when it is applied on plant tissue as a Bordeaux mixture spray.

Refractometer Readings of Plant Sap from Sprayed and Untreated Plants. The present investigation was undertaken to test, if possible, the effect of Bordeaux mixture spray upon the sap of treated plants. In order to accomplish this, refractometer readings were made daily on sap from both treated and untreated plants. The leaves of both were washed in the same solutions in order to remove spray residue when present, then after draining thoroughly they were pressed in a hydraulic press, using a uniform pressure. The plant sap was then tested for solids by the Abbe refractometer (Table 1). These percentages of solids are usually called sugars since the percentages of the other combined solids present are extremely small.

When daily examinations are made, these readings usually show that in both bean and potato plants there is a difference in the refractive index of treated and untreated plants when they are of exactly the same age and are taken from adjacent rows where soil and atmospheric conditions are the same. Numerous examinations over periods of several days after treatment indicate that as a rule the sugar content of the treated plants is lowered, for one or two days after treatment, below that of the untreated plants. The sugar content, however, soon rises in the treated plant above that of the untreated and usually remains above for a period of two or three weeks, occasionally dropping below for a short period. These data are shown in graphic form in Figures 41 and 42. Both the age of the plant and the rate of transpiration may affect this sugar content to some extent and may change the percentage or degree of difference between treated and untreated plants. These conclusions were based upon some 26,000 readings taken during June, July, August, and September. Duggar and Cooley (*8*) have shown that in potted plants the transpiration rate is higher upon treated than upon untreated plants.

TABLE 1. ABBE REFRACTOMETER READINGS OF PLANT SAP AND COMPUTATION OF SOLIDS (SUGARS)

Date Examined	Number of Days After Treatment	Untreated Potato Aver. Refrac. Index Readings	Untreated Potato Per cent Water Corrected to 20°C.	Untreated Potato Per cent Solids	Treated Potato Aver. Refrac. Index Readings	Treated Potato Per cent Water Corrected to 20°C.	Treated Potato Per cent Solids	Untreated Bean Aver. Refrac. Index Readings	Untreated Bean Per cent Water Corrected to 20°C.	Untreated Bean Per cent Solids	Treated Bean Aver. Refrac. Index Readings	Treated Bean Per cent Water Corrected to 20°C.	Treated Bean Per cent Solids
Aug. 6	1	1.3403	94.94	5.06	1.3398	95.24	4.76	1.3412	93.94	6.06	1.3420	93.74	6.26
7	2	1.3391	95.56	4.44	1.3384	96.06	3.94	1.3382	96.16	3.84	1.3390	95.66	4.34
8	3	1.3379	96.4	3.6	1.3382	96.1	3.9	1.3413	94.0	6.0	1.3401	94.8	5.2
9	4	1.3391	95.5	4.5	1.3395	95.2	4.8	1.3400	94.9	5.1	1.3428	93.1	6.9
10	5	1.3380	96.3	3.7	1.3390	95.6	4.4	1.3397	95.1	4.9	1.3405	94.6	5.4
12	7	1.3374	96.64	3.36	1.3378	96.34	3.66	1.3402	94.74	5.26	1.3413	93.94	6.06
13	8	1.3382	96.1	3.9	1.3382	95.6	4.4	1.3417	93.5	6.5	1.3410	94.3	5.7
14	9	1.3380	96.42	3.58	1.3393	95.52	4.48	1.3408	94.42	5.58	1.3420	93.72	6.28
15	10	1.3391	95.56	4.44	1.3390	95.56	4.44	1.3419	93.66	6.34	1.3419	93.66	6.34
16	11	1.3388	95.82	4.18	1.3408	94.52	5.48	1.3431	92.92	7.08	1.3438	92.52	7.48
17	12	1.3395	95.32	4.68	1.3418	93.82	6.18	1.3470	90.42	9.58	1.3454	91.42	8.58
19	14	1.3393	95.46	4.54	1.3400	94.96	5.04	1.3426	93.16	6.84	1.3438	92.46	7.54
20	15	1.3398	95.22	4.78	1.3407	94.52	5.48	1.3453	91.52	8.48	1.3450	91.72	8.28
21	16	1.3401	94.92	5.08	1.3403	94.82	5.18	1.3445	92.02	7.98	1.3448	91.82	8.18
22	17							1.3420	93.66	6.34	1.3425	93.26	6.74
23	18	1.3388	96.7	3.3	1.3388	96.7	3.3	1.3427	93.1	6.9	1.3429	93.0	7.0
24	19							1.3427	93.1	6.9	1.3425	93.2	6.8

Average refractive index readings were computed from 6400 readings; These are shown in the form of a graph in Fig. 41.
Per cent Water corrected to 20°C—were obtained from Tables 17 and 18, pp. 134–137, Cir. 44 U. S. Bur. Standards.

In very young or extremely old plants there is more fluctuation in the relative percentages of sugars, and the above-mentioned condition will frequently change from day to day. In vigorous growing plants of medium size the sugar content usually remains higher in the sprayed than in the untreated plant.

The present data obtained from refractometer tests are in agreement with the work of Cook (*5*), who found that in plants sprayed with copper the percentage of weight of the tubers compared to that of the vine is higher on treated than on untreated plants, the tubers being the natural outlet for the starch manufactured by the leaves. This stimulation of tuber growth and the relative increase in the weight of tubers are shown early in the development of the plant.

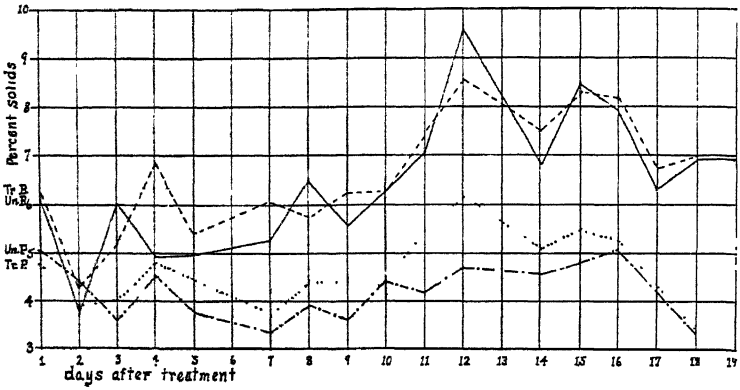


FIG. 41.—Graph showing untreated and treated bean and untreated and treated potato plants, indicating per cent of solids in plant juices. (Tr. B. = Treated Beans; Un.B. = Untreated Beans; Un.P = Untreated Potatoes; Tr.P. = Treated Potatoes.)

EVIDENCE FROM LITERATURE INDICATING ABSORPTION OF COPPER. There is no doubt that the plant is definitely affected by applications of Bordeaux mixture spray. Investigators, however, differ in their opinions concerning the degree to which this occurs and the way in which it is manifest. The great majority of data upon yields accumulated by scientific workers, over a period of 25 to 30 years indicate that the potato plant is stimulated in some way and there is greater production on treated plots even when fungous and insect enemies seem to be present in such small numbers as to cause no appreciable reduction in yield on the untreated plants. Babcock (*1*) finds this to be the case. Cook (*5*) states that as a rule potato tubers from Bordeaux mixture sprayed plots are higher in the percentages of solids, starch, and nitrogen

than are tubers from unsprayed plots. He also states that it is evident that the copper-sprayed plants generally gave an increased yield of tubers and that these increased yields followed the application of these sprays in seasons when no late blight was prevalent. The differences in yield could not be accounted for by the small number of insects present.

A few workers, on the other hand, claim that the crop is reduced in yield by Bordeaux mixture spray, and they support their belief by data. In some cases it is a well known fact that conspicuous injury and destruction of foliage occur. It is apparent that varied conditions such as different methods of Bordeaux mixture preparation, the time and number of applications, and climatic fluctuations are almost certain to give varying results. The evidence seems to indicate, however, that as a rule the plant is stimulated by applications of Bordeaux mixture.

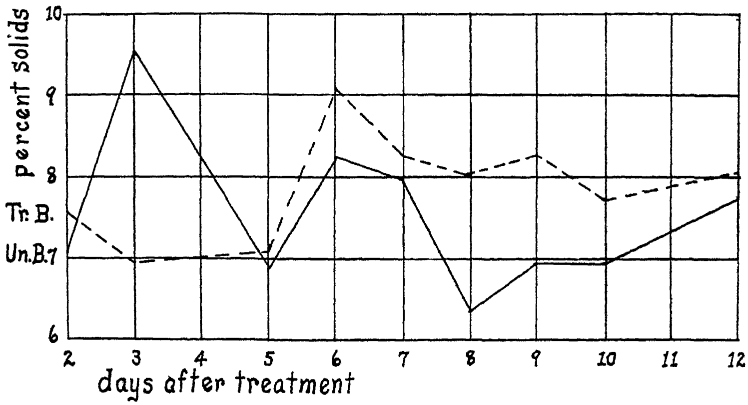


FIG. 42.—Graph showing untreated and treated bean plants, indicating per cent of solids in plant juice. (Tr. B = Treated Beans; UnB. = Treated Beans.)

Most workers have noticed that the potato foliage becomes darker green and seems more healthy in appearance when treated with Bordeaux mixture. Frank and Kreuger (*9*) have shown that the leaves are actually thickened and that the life of the plant is lengthened by Bordeaux mixture applications. The chlorophyll content is increased and correlated with this there is a rise in the assimilating capacity, more starch being formed. Lutman (*10*) found practically the same thing, and states that a small quantity of copper enters the leaf and that chemical combination takes place between the copper and the chlorophyll, this rendering the chlorophyll less soluble and less easily removed from the sprayed plant.

LITERATURE CITED

1. BABCOCK, D. C. 1917. Potato diseases. Ohio Agr. Exp. Sta. Bul. 319 p. 121–136, illus.
2. BUTLER, O. 1914. Bordeaux mixture 1. physico-chemical studies. Phytopathology 4 (3): [125]–180, illus.
3. CARTER, W. 1928. An improvement in the technique for feeding homopterous insects. Phytopathology 18:246–247.
4. CLARK, J. F. 1902. On the toxic properties of some copper compounds with special reference to Bordeaux mixture. Bot. Gaz. 33:26–48, illus.
5. COOK, F. C. 1923. The influence of copper sprays on the yield and composition of Irish potato tubers. U. S. Dept. Agr. Bul. 1146, 26 p.
6. CRANDALL, C. S. 1909. Bordeaux mixture. Ill. Agr. Exp. Sta. Bul. 135:199–296, illus.
7. DELONG, D. M. 1929. The role of Bordeaux mixture as a leafhopper insecticide. Jour. Econ. Ent. 22:345–353, illus.
8. DUGGAR, B. M., and COOLEY, J. S. 1914. The effect of surface films on the rate of transpiration: experiments with potted potatoes. Ann. Mo. Bot. Gard. 1:351–356, illus.
9. FRANK, B., and KREUGER, F. 1894. Über den reiz, welchen die behandlung mit kupfer auf die kartoffelpflanze hervorbringt. Ber. Bot. Gesell. 12:8–11.
10. LUTMAN, B. F. 1916. Some studies on Bordeaux mixture. Vt. Agr. Exp. Sta. Bul. 196, 80 p. illus.
11. PICKERING, S. U. 1907. The chemistry of Bordeaux mixture. Jour. Chem. Soc. Trans. 91 (2): 1988–2001.

PRESIDENT T. J. HEADLEE: The next paper is also by D. M. DeLong, W. J. Reid, Jr., and M. M. Darley.

THE TOXICITY OF COPPER TO THE POTATO LEAFHOPPER

By D. M. DELONG, W. J. REID, JR., and M. M. DARLEY,[1] *U. S. Bureau of Entomology, Columbus, Ohio*

ABSTRACT

Copper sulphate solutions of known strength containing 5 per cent sugars were fed to potato leafhopper (*Empoasca fabae* Harris) nymphs through capping membranes. Dilutions to and including a 1:6,500 (.0012 N) gave a rather high degree of toxicity. These nymphs lived for an average of 12 days upon a 5 per cent sugar solution and an average of three days upon distilled or tap water. The supernatant fluid from a 4–6–50 Bordeaux mixture obtained after two hours' setting, combined with 5 per cent sugar, gave a 14-day average survival. Roots of bean plants were placed in different dilutions of copper sulphate solutions, and leafhoppers were allowed to feed upon these plants. A high rate of mortality was obtained in these

[1]Suggestions, advice and criticisms regarding methods and results have been offered by Dr. N. F. Howard, U. S. Bureau of Entomology, Columbus, Ohio; Dr. Edward Mack, Department of Chemistry, Ohio State University; Dr. R. C. Burrell, Department of Agricultural Chemistry, Ohio State University; Drs. B. S. Myers, Lois Lampe, and G. W. Blaydes and Mr. K. E. Wright of the Botany Department, Ohio State University.

tests, and copper was found by chemical tests to be present in the plant juices of these leaves. Spray solutions of copper sulphate and of calcium hydroxide were used on different plants, and nymphs were placed on each of these. The copper-sulphate-treated plants showed considerable toxicity while the calcium hydroxide did not affect the leafhoppers.

A series of experiments performed in the summer of 1928 (*1*) indicated that the potato leafhopper[2] when feeding upon sprayed bean and potato plants obtained a toxic dose of copper from the plant sap. As a result of this investigation experiments were conducted during the summer of 1929 to determine, if possible, the toxicity of copper to leafhoppers, both through the medium of plant tissues and when obtained from known solutions directly through capping membranes.

FEEDING TESTS THROUGH MEMBRANES WITH DILUTIONS OF COPPER SULPHATE AND OTHER MATERIALS. Several series of tests were made with both adults and nymphs of the leafhopper to determine the toxicity of copper sulphate in solutions of various concentrations when the leafhoppers obtained the chemical by feeding directly through a membrane. Capping membranes were used for this purpose as well as feeding tubes similar to those used by Carter (*2*). The feeding solutions used in these tests were placed in small glass vials holding about 20 c.c. of liquid. The open end of each vial was covered with a membrane and this covered end fitted snugly in an opening in a straight-sided cork stopper so that the membrane was just flush with the stopper. This stopper, holding the vial, was placed in one end of a larger glass cylinder 5 inches long and 1½ inches wide, the membrane-covered end of the vial being inside the cylinder. The leafhoppers were then placed in the glass cylinder and a cheesecloth cover placed over the open end. By placing these feeding cylinders so that the source of light came through the membrane, the leafhoppers would move immediately to this spot and attempt to feed within a short time.

All dilutions of copper used for these tests were made from a stock solution marked a "1 to 100" strength and made by dissolving 1 gram of copper sulphate pentahydrate ($CuSO_4.5H_2O$) in 100 c.c. of water.

It had been determined previously that leafhopper nymphs lived for an average of 12 days on a 5 per cent solution of cane sugar, with a maximum survival of 32 days. When permitted to feed on distilled or tap water alone, the average period of survival was three days with a maximum of five days. The test in which this latter average survival was obtained might be considered a starvation-point test since very little, if any, food is obtained from distilled water. It was quite evident

[2]*Empoasca fabae* Harris.

that when leafhoppers were feeding on solutions of copper sulphate and died in about three day's time, the cause of death might have been starvation. Therefore, a 5 per cent sugar solution was used with each dilution of copper sulphate, thus making provision against death by starvation. A graph (Fig. 43) on which was recorded the average number of days survival when different strengths of copper sulphate solution were used in combination with sugar gives a curve showing relative toxicity. This curve is based on some 2600 records. Experimental data show in brief that the leafhoppers live on an average less than one day on dilutions of copper sulphate and sugar up to 1 to 300[3] (.0266N) inclusive and an average of two days on solutions of 1 to 500 (.0160 N) to 1–1,000 (.0080 N) inclusive. The average survival in days for greater

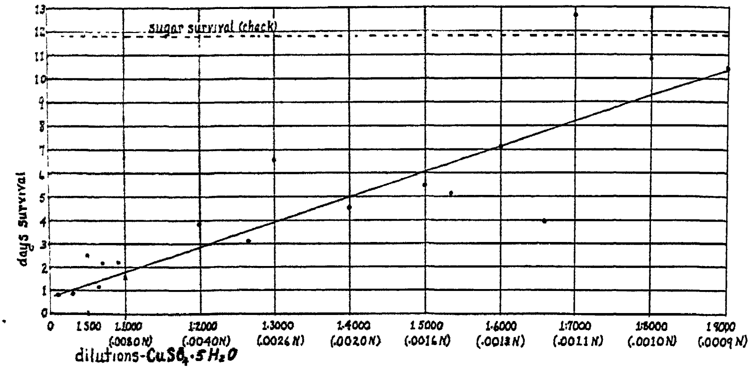


FIG. 43.—Graph indicating average days of survival of potato leafhopper nymphs which had fed upon copper sulphate solutions of different strengths combined with sugar.

dilutions, combined with sugar, was as follows: 3.6 days for a 1–2,000 (.0040 N) dilution; 6.7 days for a 1–3,000 (.0026 N) dilution; 4.6 days for a 1–4,000 (.0020 N) dilution; 5.5 days for a 1–5,000 (.0016 N) dilution; and 3.9 days for a 1–6,600 (.0012 N) dilution. Dilutions of from 1–7,000 (.0011 N) to 1–9,000 (.0009 N), although performed under somewhat lower temperatures than most of the preceding high dilutions, gave an average survival of 10 to 12 days.

TOXICITY OF COPPER IN BORDEAUX MIXTURE SOLUTION. Standard Bordeaux mixture 4–6–50 was made and allowed to settle for about two hours. The supernatant fluid was then siphoned off and combined with 5 per cent sugar solution. Leafhoppers allowed to feed upon this solution survived, on an average, 14 days. This material was tested

[3]Crystallized copper sulphate used in computing dilutions.

for copper and gave a negative test where the reaction would show the presence of copper when equivalent to a 1–50,000 solution of crystalline copper sulphate. There is certainly nothing in this solution which is toxic to insects, and when Bordeaux mixture is properly made the copper is insoluble in the supernatant fluid.

THE TOXICITY OF COPPER TO LEAFHOPPERS WHEN THEY OBTAINED IT THROUGH PLANT TISSUES. In order to test the toxicity of copper when it was available to the insects only through the medium of plant sap, the roots of young bean plants were placed in solutions of copper sulphate of different strengths. The leafhoppers were placed on the plants immediately after their roots had been put in the solutions.

The most clear-cut and striking results were obtained with a 1–100 dilution of copper sulphate. Leafhoppers feeding upon plants whose roots were placed in this solution and at an average temperature of approximately 80° F. died within six hours' time; at this time the plant showed no visible signs of the effects of the copper. At lower temperatures 97 per cent of all leafhoppers on these plants died within 48 hours.

When feeding on plants whose roots were placed in a 1–200 solution, 90 per cent of the leafhoppers died in three days, at a 1–250 solution 100 per cent died in three days, at a 1–300 solution 96 per cent died in five days, a 1–500 solution gave 69 per cent mortality in five days, a 1–900 solution gave 75 per cent mortality in five days, and a 1–1,000 solution showed a 62 per cent mortality in five days. It is thus shown that marked toxicity occurred within from three to five days for all strengths, up to and including a 1 to 1,000 solution of copper sulphate.

Strengths of from 1–1,000 to 1–7,500 gave 80 and 40 per cent mortality, respectively, in approximately 10 days, whereas the plants in water used as untreated checks gave only 15 per cent mortality over a 10-day period.

ANALYSIS OF LEAVES FOR COPPER. Leaves were taken from the plants whose roots had been placed in copper sulphate solutions at 3-day intervals and tested for copper. This test was made by expressing the plant juice from the leaves and removing the proteins by precipitation. Copper was then precipitated in appreciable quantity from leaves taken from plants held in solutions up to and including the 1–5,000 dilution. Both the hydrogen sulphide and the potassium ferrocyanide methods were used with positive reactions.

This has no practical bearing upon spraying with Bordeaux mixture but these experiments have demonstrated conclusively that copper is

taken into the plant system and as such is toxic to the leafhoppers feeding upon the plant, and at the time of the insect's death, the copper can be detected in the plant juices by chemical analysis and precipitation.

Is LIME AS TOXIC AS COPPER SULPHATE? Sprays of copper sulphate at different strengths were each applied to specific plants each day for seven consecutive days. After the seventh spray leafhopper nymphs were confined to these plants. About 50 per cent of the nymphs reached maturity but those that died showed typical symptoms of what has previously been termed "Bordeaux death." They dropped from the plants and were unable to regain their position or remain there if placed on the plant. In addition, they died in a partially molted condition.

Plants sprayed with calcium hydroxide at the rate of 6 pounds to 50 gallons of water showed no injury and leafhopper nymphs were not affected by the lime. Furthermore, nymphs which hatched from eggs that were in the tissues of these plants when they were sprayed grew to maturity upon the same plants without being affected.

Other copper sprays, such as ammonical copper carbonate, copper-fishoil soap, and Burgundy mixture have shown similar toxicity to leafhoppers except that the death rate was much smaller as compared with that from Bordeaux mixture. This was to be expected, since the copper content in these sprays is lower than that in Bordeaux mixture.

LITERATURE CITED

1. DELONG, D. M. The Role of Bordeaux Mixture as a Leafhopper Insecticide. Jour. Econ. Ent. 22:345 (1929).
2. CARTER, WALTER. A Technic for Use with Homopterous Vectors of Plant Disease, with Special Reference to the Sugar-Beet Leafhopper, *Eutettix tenellus* (Baker). Jour. Agr. Res. 34:449 (1927).

PRESIDENT T. J. HEADLEE: Next is a paper by M. P. Jones.

THE ONION MAGGOT (*HYLEMYIA ANTIQUA*) IN OHIO, 1929

By M. P. JONES, *Columbus, Ohio*

ABSTRACT

The maggots caused about a million dollar loss to onions in some Ohio marshes. Bordeaux oil emulsion and the proprietary oil emulsions, which were used, gave about 45 per cent increase in yield. It was necessary to devise sprayers suitable to the larger marshes. In general three types of sprayers were used: First, the Bolins, second, a Myers spray pump and 100 gallon tank mounted on a Ford chassis, and third, an outfit constructed by a farmer consisting of 50 gallon barrel, spray pump, pump jack and a small motor, mounted on a Ford chassis.

During the summer of 1928, farmers in Ohio marshes noticed that many of their onions were dying because of onion maggot injury. The growers began to seek help from both the Ohio Experiment Station and the extension Service of the Ohio State University. It was then too late to give any assistance that year and as a consequence the crop was reduced several thousand bushels. In fact, o thene of leading growers and shippers stated that there was a million dollar loss in Hardin County alone due to onion maggot. There is no doubt but what the maggots have been present in Ohio for a great many years, but for some reason or other they have never caused commercial loss until the last few years.

Nearly all onions in Ohio are grown for table use. Very few sets are grown and these are generally planted on the uplands where the maggot has not constituted a menace. The seed for the large onions is planted during April in muck soil, usually in rows 14 inches apart. The yellow varieties are more universally planted than the white.

Early in the spring of 1929 the writer held a meeting at McGuffey, which is the largest onion center in Ohio. At this meeting preliminary results, obtained by the Ohio Experiment Station together with the results of the work in Illinois by Flint and Compton and the work in New York by Glasgow and Cook, were discussed. The greater number of the farmers thought that spraying was out of the question, but a few decided to try it. Arrangements were made for demonstration plots in each of the Hardin County marshes, namely, Scioto and Hog Creek. Even though these were not carried on from the research standpoint, the data collected may be of interest to some research workers.

The flies came out in great swarms the week of May 27, but for some reason the maggot population did not build up in the green onions in the Scioto Marsh. The data from the Scioto Marsh plots was temporarily disregarded, because of the light infestation and the location of the plots with reference to the soil level. Unfortunately, the check plots were on the head lands and because of the wet season onions on the raised portions of the field were universally better.

It was noticed, however, that the spray killed very young weeds and retarded growth of the older ones, so that where spraying was done early weeding was not necessary for more than two months. Normally they must start weeding within a very few weeks after planting. Because of the apparent weed control, the cooperator at the Scioto Marsh expects to spray this year, which will also be good insurance against onion maggot injury. Other growers in the marsh,

who rigged up sprayers, expect to spray again even though some started spraying too late for favorable results last year.

In the Hog Creek Marsh the maggots caused more injury and the results obtained from the demonstration plots were quite different. The yield of the entire crop was greatly reduced, because of a heavy wind storm about a month before harvest, which broke the tops of the onions.

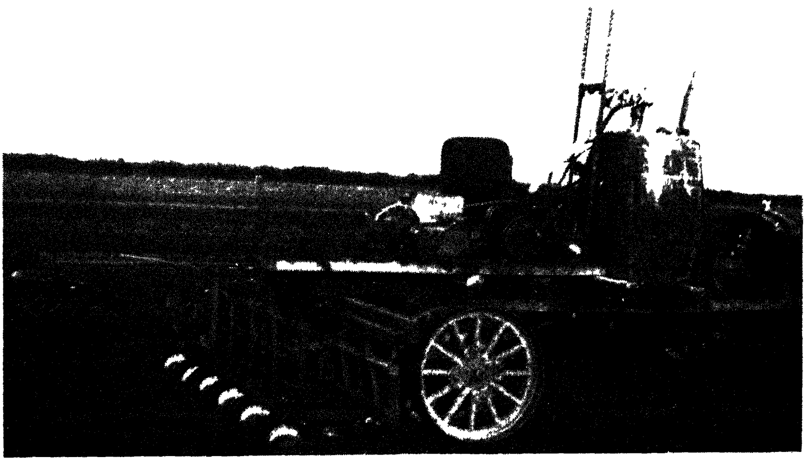
The results for last year showed little difference in the yield between oil alone and where oil was used in combination with Bordeaux. The boiled lubricating oil compared favorably with the proprietary oils.

At harvest time the demonstration showed, from counts made by Jay Sleesman and the writer, that each of the sprayed plots yielded higher than the checks and that the average of all sprayed plots was a 45 per cent increase over the average of the checks. The onions in 30 crates were counted to get the comparative size from sprayed and unsprayed plots. The crates were filled to weigh 61 pounds gross. The average number of onions in the crates from sprayed plots was 490 as compared to 406 in the crates from unsprayed plots. The difference could not be attributed to spray alone, because thinning due to maggots would increase the size of each onion.

The per cent of infestation at harvest time from a count of about 15,000 onions showed almost 1/3 as many of the sprayed onions were infested as the checks. The per cent was very low in either case.

One of the greatest developments in the Hardin County Marshes was that of sprayers to meet demands of the farmers. Three types in all were used. The small tractor sprayer of the Bolins type was used by some growers. These tractors were too small to carry sufficient material to spray rows a quarter or a half of a mile long even though the spray tank was increased to the maximum carrying capacity of the tractor. Many onions were seeded with seven row drills, hence a boom with seven nozzles was necessary. Two larger type sprayers were developed which met the requirements quite well. A model T Ford chassis with motor was used to convey the sprayer. Some alterations were necessary, however, to carry this through the muck soil. The rubber tires were removed and 1/4 inch by 6 inch strap iron was bent around and bolted in place of the rubber tires. Additional wheels were attached to the outside of each rear wheel. The wood cylinder, 7 1/2 inches in diameter by 10 inches long, was placed between the original and the extra wheel and both wheels were tied together with U bolts around the spokes. The extra bearing surface was to carry the additional weight of the spray materials.

1—Center foreground—7 rows unsprayed check
(absence of onions due to onion maggots)
Right and left background—sprayed with Bordeaux oil



2—A farmer constructed sprayer as described in the narrative

Thus far both sprayers were constructed the same, but in sprayer A (Plate 15) the drive shaft was cut off close to the transmission and a Chevrolet transmission inserted. This feature gave a wide variation of speeds and the outfit could be made to move very slowly. The driver's seat was shifted well to the left and a 50 gallon barrel equipped with barrel sprayer was placed to the right. A pump jack was installed to the rear of the spray barrel and this was driven by a small gasoline engine. (In this case the motor from a May Tag washer.)

Another feature which may be of interest was that this sprayer was equipped with cultivating tools, so that spraying and cultivating could be accomplished in one operation. The cultivation attachment consisted of a series of Planet Jr. wheel hoes fastened to a rigid bar. This bar was suspended from three sections of roller door carriage, thus making the steering of the cultivator, to which is attached the spray boom, a separate unit from the other part of the chassis. This whole unit can be raised and lowered much in the same way as the discs on a grain drill.

With this ingenious outfit the farmer and his two boys were able to cultivate and spray about 10 acres per day. The water was hauled to the field in a large tank. The oil in a drum, copper sulfate solution in one barrel and lime solution in another barrel were hauled to the field in the rear end of a truck. Each container was equipped with spigot making it very easy to draw the desired amount of any material. The total cost of sprayer A with all attachments, except May Tag Motor, was $261.80. This included Ford chassis and motor at $78, total blacksmith charges $101, cultivating tools $41.80 and spray pump, pump jack, boom and nozzles $41.

Sprayer number B used the model T Ford as in sprayer A, except that between the Ford transmission and the Chrevolet transmission a sprocket wheel was inserted from which power was derived to drive the spray pump. A Myers spray pump and a 100 gallon tank were placed just back of the driver's seat. A spray boom was attached to the rear of the chassis and one man walked behind to guide this spray on the row. No attempt was made to attach cultivators. Growers with the latter type of sprayer drove to a large gravity tank located by a well or drainage ditch to refill.

The total cost of sprayer B was $310. This includes Ford chassis and motor at $25, cost of overhauling chassis $60, and the spray tank, pump, nozzles and fittings at $225.

The Bordeaux oil combinations have given favorable results and with the progress in developments of spray equipment the growers feel that they can prevent maggot injury to the onions.

PRESIDENT T. J. HEADLEE: Now we have a paper by F. E. Whitehead.

THE PEA WEEVIL PROBLEM

By F. E. WHITEHEAD, *Stillwater, Okla.*

ABSTRACT

Although the pea weevil, *Mylabris pisorum*, is one of our oldest pests and one whose control has long been considered solved, the writer is unaware of any place it is being controlled. Our present controls are based on the assumption that the weevil in the seed is the important source of infestation. The writer has planted weevil infested peas under weevil tight cages and grown them to maturity without infestation occurring, which indicates that weevil planted in seed is not the source of infestation.

By overwintering weevil in protected places out of doors, he has brought as high as 87 per cent of them through the winter, thus showing that it is possible for a high percentage of weevil, escaping from the peas before being stored, may overwinter out of doors and therefore may be important as the source of infestation.

The pea weevil (*Mylabris pisorum*) is one of the oldest pests of our country as well as the worst insect pest of peas known. It was first recognized in this country by Peter Kalm (7) in 1748 when he was collecting for Linnaeus. At that time he recorded it as being so numerous in parts of Pennsylvania, New Jersey, and New York, that the growing of seed peas had been discontinued. From that day to this the pea weevil has continued to cause the growing of seed peas to be discontinued in many parts of the country. At present it appears that it is likely to bring about the same conditions in the "Palouse" country, a part of northern Idaho, and eastern Washington, where the speaker has spent the greater part of his time during the past five years. Literature on the subject brings out the fact that even though entomologists have insisted for years that its control is known and easily applied, it has not been effectually controlled at any time since it was first discovered more than one and three-quarters of a century ago. This would seem to indicate that our controls may be basically wrong or at least much more ineffectual than has been maintained. Nevertheless, they are, in all essential respects, the same today as those recommended by Harris (7) 88 years ago, which consisted of destroying the weevil in the seed.

Further evidence, that our controls may be wrong is seen in the fact that even though the pea weevil is one of our oldest pests, its life history has never been definitely determined or if determined has not been recorded. The length of time spent in the egg and adult stages has been recorded in several vicinities. Chittenden (3) has determined the length of the pupal stage at Washington, D. C. The only definite record I have been able to find in American literature as to the length of the larval stage is in Crosby and Leonard (4), wherein they state, "In Italy, the larvae reaches maturity in 40 days after hatching."

Therefore, we know the length of the egg stage in various places, the larval stage in Italy, the pupal stage in Washington, D. C., and the adult stage in still other places. With such a patched up knowledge of its biology, it surely would not seem surprising if errors were made in recommending its control. It is my belief that our universally recommended control of fumigating the seed is basically wrong in that it does not strike at the true source of infestation.

Such a statement of course needs defense. One of the observations made that first led to this belief was as follows: In an isolated valley north of Moscow, Idaho, only two farmers grew peas. Each year for the preceding three years each had had his seed fumigated by a reputable seed house, whose fumigations I believe to have been effective. But still their infestations were uniformly high. This is but one outstanding example of numerous similar cases.

In order to obtain further information on this point the following experiment was conducted: Weevil tight cages sufficiently large for growing peas to maturity were constructed. In these at the regular planting time, were planted peas 50 per cent, 25 per cent ,and 10 per cent of which contained living weevil. The peas were then grown to maturity with no weevil from the outside having access to them and resulted in mature peas 100 per cent free from infestation. This experiment was repeated the following year except that this time 100 peas containing living weevil were thrown on top of the ground in one of the cages at planting time and again resulted in no infestation in any cage.

The work of the speaker was such that he was unable to be present at the time the peas were planted and during the most of the growing season either year. He therefore feels that further work is necessary before stating that such results, would always be obtained. However, should other experiments give similar results, it will be very strong evidence, that weevil planted in seed, instead of being the important source of infestation is of no importance at all.

Other possible sources of infestation are weevil escaping in the spring from stored peas and those escaping from the peas before being stored and overwintering out of doors. The escape of weevil from stored peas, may be prevented by storage in weevil tight bins or bags or they may be killed by fumigation. But those overwintering out of doors, if important, constitute a great deal more complicated problem.

Most writers on the subject have assumed that with the possible exception of the south, few weevil ever successfully pass the winter out of doors. In the vicinity of Moscow, Idaho, numerous peas may be found each fall that have been deserted by the weevil and living weevil may be collected all winter. The most frequent places found being under bark and slivers of posts or trees.

Wire cages containing living weevil were placed in various types of cover in the fall, such as grass, under boards, leaves, rubbish, etc., and others in more open places. Those in the open places all died, but a large percentage of those in the more protected places were alive and vigorous the following April in spite of an unusually severe winter. In one cage placed in the rubbish at the base of a lilac bush and covered with leaves, 87 per cent of the weevil survived. Both weevil within and outside of peas were used and a much larger percentage of those outside peas, survived than of those within.

With these facts in view it seems entirely possible that the real source of infestation is entirely different from that which we have always considered it to be and may prove the almost universal failure of our controls to be due to wrong principles involved rather than to poor application.

In closing it is desired to recognize the fact that Fletcher, Gillette, Felt, Bethune, Back and others have recommended the early harvesting and fumigation of peas and the destruction of peas left in the field, or any other measures to prevent the escape of weevil in the fall. However, these have been recommended only as supplementary measures and no record is made of any experimental work being carried on to determine their effectiveness, which leaves the problem open for further investigation.

Literature Cited

1. Back, E. A. Weevils in Beans and Peas. W.S.F.B. 1275.
2. Bethune, C. J. 1909. Injurious Insects in Ontario in 1908, Ontario Ento. Society Report 39– P. 132.
3. Chittenden, F. H. 1898. Insects Injurious to Beans and Peas, W.S.Y.B. 1898. P. 233.
4. Crosby, C. R. and Leonard, M. D. 1918. Manual of Vegetable and Garden Insects. P. 54.

5. FLETCHER, J. 1903. Can the Pea Weevil be Exterminated? W.S.D.A. Div. of Ento. Bull. 40—pp. 69–73.
6. GILLETTE, C. P. 1892. Observations upon Injurious Insects for the Season of 1892. Colo. Agri. Exp. Bull. 19.
7. HARRIS, T. W. 1841. Insects of Massachusetts Injurious to Vegetation. Page 45.

PRESIDENT T. J. HEADLEE: The next paper is by H. H. Schwardt.

BORAX AS AN INSECTICIDE FOR PROTECTING SEED[1]

By H. H. SCHWARDT, *University of Arkansas*

ABSTRACT

Powdered borax applied to corn at the rate of ten ounces in a bushel has effectively controlled the rice weevil. The four-spotted bean weevil has been controlled by the application of twenty ounces of borax in a bushel of cowpeas.

One of the outstanding problems of southern agriculture is that of protecting stored seed from weevil attack. Corn and wheat suffer heavily from the combined attacks of the rice weevil[2] and the angoumois moth.[3] Cowpeas are often severely damaged by the four-spotted bean,[4] and cowpea[5] weevils.

The use of a poison or repellent dust to control pests of stored seeds has been suggested by Metcalf (5), and more recently by Mackie (3), and Zacher (6). Metcalf recommended the use of air-slaked lime for the protection of cowpeas. One part of lime to two parts of cowpeas was a fairly effective rate of application. Mackie found that copper carbonate, applied at the rate of two ounces a bushel, controlled the granary weevil in wheat. Zacher (6) reports that dusts based on copper carbonate and compounds of mercury and arsenic gave fair control of the granary weevil. Probably more important is his observation that such a cheap and non-poisonous dust as magnesium oxide is also effective. However, Zacher's data for this dust are limited to observations made on only a hundred individuals of the granary weevil.

Experiments made with both poisonous and non-poisonous dusts at the Arkansas Agricultural Experiment Station in 1928 showed the possibility of controlling weevils in stored grains by this method. Calcium arsenate, lead arsenate, and sodium fluoride were the poisonous dusts tested and all proved highly effective. For non-poisonous dusts,

[1]Research Paper No. 163, Journal Series, University of Arkansas.
[2]*Sitophilus oryza.* (L.)
[3]*Sitotroga cerealella.* Oliv.
[4]*Bruchus quadrimaculatus.* (Fab.)
[5]*B. chinensis.* L.

sodium carbonate and borax were used. Sodium carbonate was ineffective, but it at once became apparent that borax was very effective. In both the early experiments and those reported in this paper, borax gave almost a 100 per cent kill of weevils in every test made.

Corn treated with borax at the rate of ten ounces to a bushel was put up in ventilated quart cans and each can supplied with 25 adults of the rice weevil. Untreated cans of corn, supplied with the same number of weevils, were provided as checks. After periods varying from four to seven months, all cans were opened, live and dead weevils counted, and the condition of the grain noted. Numerical results are given in Table 1. In every case the check cans contained large numbers of live and dead weevils, and the grain was completely ruined. The treated samples, however, contained a small number of dead weevils, practically no live weevils, and the grain was in almost perfect condition. That reproduction did occur to a slight extent is shown by the fact that more than 25 dead weevils were found in each treated sample. Germination tests made on borax-treated corn have shown that the viability was not lessened.

TABLE 1. *Sitophilus oryza*. NUMBER OF WEEVILS FOUND IN TREATED AND UNTREATED CORN AFTER A FOUR-MONTHS EXPOSURE TO INFESTATION

Treated with Borax, 10 ozs. per Bushel			Untreated		
Live	Dead	Total	Live	Dead	Total
1	34	35	524	168	692
0	35	35	191	128	319
0	71	71	474	102	576
0	50	50	227	141	368
0	60	60	281	105	386
0	39	39	183	135	318
0	35	35	351	101	452
0	40	40	248	207	455
0	208	208	955	59	1014
0	60	60	606	51	657
1	151	152	589	43	632
2	190	192	1356	278	1634
0	81	81	1294	93	1387
1	230	231	1174	92	1266
0	79	79	1105	108	1213
5	1363	1368	9558	1811	11369

Only a few tests have been made on cowpeas, but the results are encouraging, and further tests are now in progress. Cowpeas were treated at the rate of 20 ounces of borax in a bushel of peas, and each can supplied with 25 adults of the four-spotted bean weevil. After three months, treated samples were practically uninjured, had not decreased in viability, and contained only small numbers of dead weevils. In the same length of time, check samples were reduced

13 per cent in weight, they contained large numbers of live weevils, and the germinating power of the seed was reduced from 85 to 55 per cent, due to weevil damage. Numerical data are presented in Table 2.

TABLE 2. *Bruchus quadrimaculatus*. NUMBER OF WEEVILS FOUND IN TREATED AND UNTREATED COWPEAS AFTER A THREE-MONTHS EXPOSURE TO INFESTATION

Treated with Borax, 20 ozs. per Bushel			Untreated		
Live	Dead	Total	Live	Dead	Total
2	48	50	1010	755	1765
1	55	56	762	682	1444
0	69	69	618	344	962
0	55	55	1007	610	1617
0	73	73	1078	561	1639
3	300	303	4475	2952	7427

The action of borax on these insects is not well understood at present. It has been observed that very little feeding takes place in treated corn, also that few or no eggs are deposited. Two hundred kernels of corn taken at random from several treated samples were found to contain only two eggs, and 14 feeding punctures. These samples had been exposed to weevils for five days. Two hundred kernels taken from untreated samples exposed to weevils for five days, contained 68 eggs, and 70 feeding punctures. Similar counts were made on lots of a thousand cowpeas which had been exposed to a heavy infestation of the four-spotted bean weevil for three months. On a thousand treated cowpeas, only 125 eggs were found. A thousand untreated cowpeas contained 4,868 eggs, and only two peas in the thousand were without eggs. The rice weevil is killed by borax in approximately eight days. It starves in about the same length of time. The fact that very few feeding punctures were found on treated corn suggests that borax either acts by contact, or is repellent to the extent that weevils starve rather than feed on treated grain. Both Mackie (3) and Zacher (7) believe the dusts which they used acted entirely by contact.

Borax is not poisonous to animals, but apparently is detrimental if fed for a period of time. Hanzlik, Talbot, and Gibson (1) fed borax to adult rats at the rate of 3.7 milligrams, per kilogram, per day. Over a period of time these rats lost 17 per cent of their original body weight. Borated food was distasteful to the rats, and was consumed in smaller daily amounts than normal food, which may account for the loss. These investigators conclude that continued use of borated food is detrimental. Mathews (4) states that ingestion of borax causes a reduction in the amount of oil secreted by skin glands, and thereby causes the hair to fall. Kahlenberg (2) found that borax was not absorbed through

human skin, although boric acid passed through the skin and was present in the urine within five minutes.

Borax-treated grain cannot be recommended as food for live stock until more is known about its physiological effect, or until an economical method of removing it is devised.

Planting borax-treated seed will not add a toxic amount of boron to the soil. Planting corn treated at the rate of ten ounces in a bushel adds less than two ounces of borax to each acre. This amount is negligible.

Literature Cited

1. Hanzlik, P. J., Talbot, E. P., and Gibson, E. E. 1928. Continued administration of iodide and other salts. Arch. Int. Med. 42:579–589.
2. Kahlenberg, Louis. 1924. On passage of boric acid through the skin by osmosis. Jour. Biol. Chem. 62:149.
3. Mackie, W. W. 1925. Prevention of insect attack on stored grain. Calif. Agr. Expt. Sta. Cir. 282.
4. Mathews, Albert P. 1916. Physiological chemistry. Wm. Wood amd Co., New York.
5. Metcalf, Z. P. 1917. Lime as an insecticide. Jour. Econ. Ent. 17:74–78.
6. Zacher, F. 1929. Magnesiumoxyd, ein neues, unschädliches und wirksames Mittel gegen Kornkäfer und andere Vorratsschadlinge. Mitt. Ges. Vorratsschutz (Berlin) 4:49–52. In Rev. of App. Ent., Ser. A, Vol. 17:641.
7. Zacher, F. 1929. Ein neues wirksames Mittel gegen Kornkäfer und andere Vorratsschädlinge. Nachr. Bl. deuts. Pfl. Sch. Dienst 9:67–68. In Rev. of App. Ent., Ser. A, Vol. 17:641.

President T. J. Headlee: The next paper is by W. P. Flint.

EFFECT ON INSECTS OF TREATING SEED CORN WITH CERTAIN FUNGICIDES[1]

By W. P. Flint, *Urbana, Ill.*

Abstract

During the past four years hundreds of farmers in the corn belt have been using certain fungicidal treatments for seed corn. Some of the companies making these fungicides have claimed that they would act as insecticides. The results of a series of tests extending over several years indicate that such is not the case.

During the past few years Federal and State Pathologists have discovered methods of controlling some of the diseases which infect seed corn by treating the seed at the time of planting with certain chemical dusts. It has been demonstrated by various experimental workers that the treatment of seed corn with the proper chemicals increases

[1]Contribution No. 1 from Natural History Survey Project 3. 1.

the yield. As a result of this experimental work, manufacturers have placed upon the market a number of commercial seed corn treatments.

Most of the manufacturers of these dusts have not claimed that their products have any effect as insecticides. Some of the manufacturer,s however, in advertising their products and also on the labels of the containers, have stated that the materials which they are putting out for seed corn treatment would control not only certain fungi which infect the corn kernels or are carried over from year to year in the soil, but that they would also control insects which attack corn in the ground shortly after planting. In some cases their claims have been extended to cover not only the seed corn in the ground, but also the young corn plant.

In order to find out the effect of these treatments as insecticides, a series of tests have been conducted in Illinois covering the period of four years. In all of these tests the materials were applied to the corn according to the directions given by the manufacturers and corn planted in fields at several points throughout the state. In making these tests fields were selected which included several different rotations, including corn after corn, corn after small grain, and corn on sod ground. When the corn was from six to eight inches high the hills were dug and carefully examined for the presence of insects.

The results of the tests which have extended over two years or more are shown in the following table. A study of this table shows at once that none of the materials tested show any marked insecticidal efficiency. There are indications that one or two of the materials may have an effect in slightly reducing the numbers of certain insects. This is true in the case of Semesan Jr. where tests on 532 hills of corn covering a four-year period have shown a rather consistent reduction in the number of corn field ants and corn root aphids. The number of wireworms in the hills treated with Semesan Jr. were somewhat greater than the average number found in the check and with other insects the infestation was approximately the same. It is obvious from a study of the table that none of the materials so far tested would be of sufficient value as insecticides to warrant the expense of using them as seed corn treatments to prevent insect injury.

TABLE 1. RESULTS OF TESTS WITH SEED CORN TREATMENTS AS INSECTICIDES

Treatment	No. Hills	Per cent Hills Infested by Corn Field Ants	Corn Root Aphids	Corn Seed Maggots	White Grubs	Wireworms	Corn Seed Beetles	Thief Ants
Four years' tests:								
Uspulum	420	15.2	11.2	9.3	5.2	8.0	—	—
Semesan, Jr	532	10.1	6.0	3.0	1.3	8.3	1.5	.8
Three years' tests:								
Semesan	356	19.1	14.6	6.7	2.5	5.3	1.4	.6
Std. Oil H-1	332	15.0	10.0	10.0	4.5	4.0	4.5	3.6
Corona 620	316	22.8	19.9	3.1	4.4	6.0	.3	2.2
Bayer Dust	268	17.1	14.5	6.7	2.6	5.6	1.1	—
Field No. 54	381	6.8	6.5	—	.3	9.4	2.2	—
Plantaide	384	15.9	11.4	.3	1.8	8.0	1.0	.5
Two years' tests:								
Bayer Copper Dust	184	13.0	10.3	—	1.6	6.4	—	1.0
Semesan 13-U	340	26.1	18.5	.9	4.7	10.0	.9	.6
Corona 640-S	220	24.5	21.3	2.7	4.5	3.1	1.8	.4
Marley's Copper Dust	252	7.5	5.9	—	—	9.9	—	.8
Ceresan	256	16.0	8.9	.4	.8	8.9	—	1.2
Carbola	252	12.7	10.3	—	1.1	16.0	—	1.9
Merko	256	19.1	14.0	.4	—	4.0	—	1.6
Sterocide	256	19.1	11.7	—	1.1	10.1	.4	3.2
Checks	2754	15.0	9.5	3.5	2.7	5.0	3.6	2.7

Section of Apiculture

Meeting was opened at 9:40 A.M., January 1, 1930.

PART I. BUSINESS PROCEEDINGS

CHAIRMAN BENTLEY nominated the following committees:

Nomination Committee—J. E. Echart, Chairman, F. B. Paddock and E. C. Cotton.

Resolutions Committee—S. W. Bilsing, Chairman, Kenneth Hawkins and O. W. Park.

Resolutions read by Dr. Bilsing.

MR. PHILLIPS: Why should apiculture section make an expression regarding the Mediterranean fruit fly?

CHAIRMAN BENTLEY: This section should concur and support the action of the general association.

WHEREAS, The presence of the Mediterranean Fruit Fly in Florida creates a situation fraught with the gravest danger to the horticultural and agricultural industries of the Southern and Western States, and

WHEREAS, The presence of this pest, one of major importance, constitutes a threat to the prosperity of the areas affected and exposed, and unless eradicated, will also affect very materially the interests of the consuming public of the nation, and

WHEREAS, By reason of this situation, the problem is one of national rather than sectional import, and

WHEREAS, The program of eradication adopted by the Federal Government has been prosecuted vigorously and effectively, and

WHEREAS, Competent and able authorities, after intensive study, are convinced that eradication is not only possible, but is actually being accomplished, now, therefore,

BE IT RESOLVED, by the Section of Apiculture, American Association of Economic Entomologists in session at Des Moines, Iowa, this 1st day of January, 1930, that the program as adopted and announced by the Secretary of Agriculture, Honorable Arthur M. Hyde, should be supported by the public and the scientific workers of this country, and further, that the appropriation of adequate funds by Congress for the prosecution of this project is of paramount importance and should be made speedily available.

BE IT FURTHER RESOLVED, by the Section of Apiculture, American Association of Economic Entomologists in session at Des Moines, Iowa, this 1st day of January, 1930, that we do hereby endorse the efforts of the American Honey Institute to further the use of honey.

Moved by Mr. Park and seconded by Mr. Cotton that the resolutions be accepted. Carried.

Moved by Price and seconded by Bentley that the second resolution be adopted. Carried.

Nomination Committee made the following report:

R. L. Parker, S. W. Bilsing—Chairman

F. B. Paddock, E. N. Cory—Secretary

Vote taken by ballot and R. L. Parker was elected Chairman; F. B. Paddock, Secretary.

CHAIRMAN BENTLEY: I wish to thank you all on the program and am sorry that there is not a larger attendance, but the competition is rather keen this morning with the interesting papers being given in the other room. We are anxious that the incoming secretary lay quite a bit of stress on trying to build up a larger program next year. Officials should see if we cannot arrange for a little more time for our meetings next year. I thank you one and all for the help you have given me during the past year.

Motion moved and seconded to adjourn. 12:45 P.M.

G. M. BENTLEY, *Chairman*

F. B. PADDOCK, *Secretary*

PART II. PAPERS AND DISCUSSION

HISTORY AND ACTIVITIES OF THE SECTION IN APICULTURE

By CHAIRMAN, G. M. BENTLEY

As it seems to be the custom for a historical sketch of an organization after it has been functioning a few years, this fact has suggested itself as an appropriate subject for the Chairman's address this year.

It has now been 18 years since the Section of Apiculture came into being. The name of the section has changed once during this period. As with similar organizations, it has evolved from a very simple beginning to a section of no small importance. From a small gathering of six or eight interested in apiary inspection service and holding meeting at night or the noon hours, for there was no recognition of the section on the printed program of the American Association of Economic Entomologists, the section has had a wholesome annual growth.

Early in the history of the Section it was found to interest many entomologists, the topics discussed being of a wide importance, and as time went on the attendance at these special sessions increased. An attempt was made to hold an apiary inspectors' section similar to the one held for horticultural inspectors. Mr. A. F. Burgess, at that time Secretary of the Association of Economic Entomologists, was very receptive and did much to provide on the programs a brief space for

this growing section. A change in the Constitution of the American Association of Economic Entomologists had to be made and this accomplished; there had to be a Committee of Affiliation appointed to get the Section properly lined up with the Entomologists' Section. This arranged we would have the Section set some time on the regular programs.

The requests of the committees met with favor and this Section really had its birth in 1913 with Dr. Wilmon Newell, then at College Station, Texas, as President and Dr. E. F. Phillips, Apiculturist, U. S. Bureau of Entomology, Washington, D. C., as Secretary.

Meeting as an orphan gathering the year previous, B. N. Gates of Amherst, Massachusetts and Dr. E. F. Phillips were President and Secretary, respectively.

On the program in 1913 there were two papers presented, viz: "The Essentials of a Good Apiary Inspection Law" by Dr. Wilmon Newell, and, "Beekeeping and Apiary Inspections in Missouri" by Leonard Haseman.

The Section of Apiary Inspection in December 1914 held a night session with a more pretentious program with four presenting papers. These were:

Address of the Chairman—Wilmon Newell

"Distribution of American Foul Brood and European Foul Brood in the United States" by Dr. E. F. Phillips.

"A Simple Record System for Apiary Inspection" by W. E. Britton.

"Inspection as a Unit in the Massachusetts Apicultural Service" by Burton F. Gates.

At this meeting Dr. Wilmon Newell was Chairman and N. E. Shaw, Secretary.

Association of Apiary Inspectors of the United States and Canada

On December 30th, 1911, in Washington, D. C., there was formed a temporary organization of the above name with a view to increasing the efficiency of apiary inspection and to bring about a greater uniformity in the laws and more active cooperation between the various inspectors.

A committee on permanent organization was formed to report at a meeting to be held in Cleveland, Ohio, in December, 1912, in connection with the meeting of the Association of Economic Entomologists. Professor Wilmon Newell, College Station, Texas, was Chairman of this Committee.

A standing committee was also appointed on legislation for the purpose of drawing up a law incorporating the necessary and desirable features. The undersigned was appointed Chairman of this Committee.

All apiary inspectors and official entomologists of the United States and Canada who are interested in the advancement of apiculture are invited and urged to join in this movement for an increased efficiency in the fight against the brood diseases. For the present it was decided to levy an assessment, $1 per year, on each member

to pay necessary expenses. It is hoped that arrangements may later be perfected for affiliation with the Association of Economic Entomologists. Requests for membership and the assessment may be sent to the undersigned.

Respectfully,

Dr. Burton N. Gates,
Amherst, Mass.,
Chairman.

E. F. Phillips,
Bureau of Entomology,
Washington, D. C.,
Secretary.

Program, Wednesday, January 1, 1913. 1.30 p.m.

—Action on proposed amendment to the constitution.

Strike out the first sentence in Article II, Section 1. In the following sentence after the word "entomologists" add "horticultural or apiary inspectors," so that the sentence will read as follows: "All economic entomologists, horticultural, or apiary inspectors employed by the federal or state governments . . . may become members." In Article III, Section 1, omit the last sentence, which provides for the appointment of the membership committee by the President of the Association.

From: Journal of Econ. Ent., Vol. 6, No. 2, p. 19.

Report of Committee on Amendments to the Constitution

The following changes in the constitution have been proposed:

Strike out the first sentence in Article II, Section 1. In the following sentence after the word "entomologists" add "horticultural or apiary inspectors employed by the federal or state governments may become members. Making the Section read as follows:

Section 1. All economic entomologists, horticultural or apiary inspectors employed by the General or State Governments or by the State Experiment Stations, or by any agricultural or horticultural association, and all teachers of economic entomology in educational institutions and other persons engaged in practical work in economic entomology may become members.

* * * * * *

This committee approves these changes and recommends their adoption.

Respectfully submitted,

W. E. Britton, *Chairman*
Wilmon Newell,
A. W. Morrill,
Committee.

Report of the Committee on Affiliation

Journal of Econ. Ent., Vol. 6, p. 20.

Whereas; a committee of this Association has conferred with similar committees of the American Association of Official Horticultural Inspectors and the American Association of Apiary Inspectors for the purpose of considering a plan whereby affiliation may be brought about with this Association, and,

Whereas; it is the opinion of the members of these committees that affiliation is desirable and will bring about better results and at less expense to the members than by maintaining separate and distinct organizations.

Resolved; That the plan outlined below be submitted to each Association concerned at its forthcoming annual meeting and that the same shall be put in force immediately if approved by the Associations concerned.

PLAN

In order to bring about affiliation, the American Association of Economic Entomologists agrees to amend its constitution to enable the present members of the American Association of Official Horticultural Inspectors and the American Association of Apiary Inspectors to become members and that said amendment will be made by striking out the first sentence of Article II, section 1 of the constitution, which reads as follows: "The membership shall be confined to workers in economic entomology," and in the following sentence after the words "entomologists" there shall be added words "or horticultural or apiary inspectors," so that the sentence will read, "All economic entomologists, horticultural or apiary inspectors employed by the Federal or State governments—may become members.

The members of the American Association of Official Horticultural Inspectors and American Association of Apiary Inspectors, who are not at present members of the American Association of Economic Entomologists, will, after making regular application for membership, be admitted on the same basis as other members.

After the affiliation has been accomplished, the annual meetings of the American Association of Economic Entomologists shall be arranged so that the Horticultural Inspectors may meet as the section of Horticultural Inspection, and the Apiary Inspectors may meet as the section of Apiary Inspection and the programs shall be made up so that as few papers as possible of mutual interest shall be presented at the same time before the American Association of Economic Entomologists and its sections.

The American Association of Economic Entomologists further agrees that one vice-president of its Association shall be a recognized Horticultural Inspector and he shall have general direction over and preside at, the meetings of the section of Horticultural Inspection and a similar arrangement shall be put in force for the section of Apiary Inspection. The secretary of the American Association of Economic Entomologists will have charge of the preparation and arrangements for the meetings, the general make-up of the program and the publication of the proceedings of the Association. Each section shall select its own secretary to keep a record of the proceedings and discussions at the sectional meetings and he shall prepare them for publication. It shall be the privilege of each section to bring any matters of special interest in its work to the attention of the American Association of Economic Entomologists for action by that Association.

The proceedings of the American Association of Economic Entomologists and sections, together with such papers as may be presented, shall be given equal privileges for publication in the JOURNAL OF ECONOMIC ENTOMOLOGY.

T. B. SYMONS,
A. F. BURGESS,
T. J. HEADLEE,
Committee.

MR. E. P. FELT: It seems to me that we ought to act first on the report of the committee on amending the Constitution and I move that the report of this committee be adopted.

By vote of the Association the report was adopted.

PRESIDENT W. D. HUNTER: Is there any further discussion? If not, I will now put the motion to accept the report of this committee.

The motion was duly carried.

A report was read by Mr. Wilmon Newell in behalf of the Apiary Inspectors:

Apiary Inspectors Communication

To the Association of Economic Entomologists: The Association of Official Apiary Inspectors of the United States and Canada, through the undersigned committee, request permission to affiliate with your Association as a "section" thereof, the chairman of such "section" to be a vice-president of your Association, and the proceedings of the "section" be published as are other proceedings of the Association of Economic Entomology.

Wilmon Newell,
S. J. Hunter,
T. J. Headlee,
Committee.

In view of the absence of Mr. Symons, chairman of the Committee on Affiliation, action on this request was postponed until the next session.

Journal of Economic Entomology, Vol. 6, No. 2, p. 6.

Report of the Committee on the Constitution

Considering that the Association now has two vice-presidents, one of which presides over the section of Horticultural Inspection and the other over the section of Apiary Inspection; that in the absence of the President there is no regular officer to preside over the general meeting if held at the same time as the section meetings; and that it is often impossible for all of the officers to be present,

Therefore, the committee recommends the adoption of the proposed amendment to the Constitution as published in the program providing for "one-vice-president and an additional vice-president for each section."

* * * * * *

W. E. Britton,
S. J. Hunter,
Franklin Sherman, Jr.,
Committee.

Report of Committee on Relationship of Section and Branches to the Central Association

Your committee appointed to consider the relationship of sections and branches to the central organization respectfully submits the following:

We recommend that the official name of the Horticultural Inspectors be changed from American Association of Official Horticultural Inspectors to Section on Horticultural Inspection.

We recommend that the official name of the apiary inspectors be changed from Section on Apiary Inspection to Section on Apiculture, and that their activities be extended to include research in apiculture and education in apiculture.

As a guide in establishing any future sections and to record a definition of the activities of existing sections, we recommend that the purposes of sections be understood to be to discuss topics which are of such special nature as to be of only general interest to the majority of the members and of special interest to a limited number.

Respectfully submitted,
R. A. Cooley,
J. G. Sanders,
E. F. Phillips,
Committee.

MR. R. A. COOLEY: In connection with this report, I would like to say in regard to the change in the name of the Section of Apiary Inspection that this is desired by that section so as to enable it to consider research and educational matters in connection with apiculture as well as inspection work. There is, of course, no membership in the sections other than membership in the central Association and any members of the Association are permitted to attend meetings of the sections and take part in their deliberations.

I am quite certain that this statement will clear up some uncertainty among our membership. Papers presented at the sections are printed in the JOURNAL, and it is of course understood that no action or policy can be taken by a section that would commit the Association without referring the matter to it for approval.

By vote of the Association the recommendations were adopted.

At the 1915 meeting held at 8:00 P.M. there were four papers presented, viz:

"The Function of the Apiary Inspection Section"—E. F. Phillips

"The Desirability of Inspection Work from the Standpoint of the Queen Breeder"—E. R. Root

"Outline of Apiary Inspection in Ontario"—Morley Pettit

"Suggestions for Efficiency and Economy in Apiary Inspection Service"—H. A. Surface.

This year Dr. E. F. Phillips of Washington, D. C., was our Chairman and N. E. Shaw, Columbus, Ohio, Secretary.

The Section of Apiary Inspection in 1916 held a night meeting with the presentation of seven papers. Dr. T. J. Headlee gave the address as Chairman. The other papers were:

"Some New and Practical Methods for the Control of European Foulbrood"—E. G. Carr

"The Way I would Like to Carry on Bee Disease Control"—Morley Pettit

"Problems of Bee Inspection"—Frank C. Pellett

"The Results of Apiary Inspection"—E. F. Phillips

"The Principles of a Course in Beekeeping"—B. N. Gates

"The Opportunity and Rewards in American Beekeeping"—E. R. Root.

Mr. N. E. Shaw, Columbus, Ohio, was Secretary of the Section.

This was our first program which included subjects other than apiary inspection.

In 1917 the Section changed its name from Section of Apiary Inspection to Section of Apiculture. The Chairman this year was B. N. Gates, Amherst, Massachusetts, and the Secretary, N. E. Shaw, Columbus, Ohio. At this meeting there were six papers given.

Address of Chairman—B. N. Gates

"Important Factors in the Spread and Control of American Foul Brood"—E. D. Ball

"Extension Methods in Apicultural Work"—G. C. Cale

"An Unusual Disease of the Honey Bee"—Elmer G. Carr

"Foul Brood Eradication Work in Texas"—F. B. Paddock

"Missouri Beekeeping"—Leonard Haseman.

In the previous sessions the brood diseases and various aspects of apiary inspection service have been emphasized. Research with few papers of general interest make up the following programs.

The session on December 26, 1918 was also a night meeting. Franklin Sherman, Jr., gave the address of Chairman, and in all this meeting carried on its program of nine papers as follows:

"Beekeeping Since the Declaration of War"—E. F. Phillips
"Developing Commercial Beekeeping in a Clover Region"—Morley Pettit
"Relative Importance of Management and Breeding of Bees"—E. L. Sechrist
"The Work of the Entomologist in Developing Bee Husbandry Within the Limits of his State"—T. J. Headlee
"The Present Outlook in Beekeeping"—E. R. Root
"The Relation of Beekeeping to Bee Behaviour"—Geo. S. Demuth
"Beekeeping Club and the Work of the Apiculturist in the Division of Extension" —Geo. S. Rea
"Boys and Girls Bee Clubs"—F. C. Pellett.

The Secretary for this year was G. M. Bentley.

The increased attendance and the keen interest by the entomologists was very stimulating and the prompt response to letters sent out indicated that the Section was supplying a real need.

Now that emphasis had been directed mainly along lines of inspection service, it was deemed wise to branch out into other important phases of Beekeeping. The experiment was tried with gratifying success and the program for 1919 carried 12 papers as follows:

"Some Phases of Beekeeping in Connecticut"—W. E. Britton
"The Economic Importance of Beekeeping in Entomological Work"—E. R. Root
"What Some Entomologists are Doing for Beekeeping"—Kenneth Hawkins
"Honey Production"—G. A. Koger
"Boys and Girls Bee Clubs"—F. C. Pellett
"Adaptation of System to Locality"—F. C. Pellett
"The Relation of Bees to Fire Blight"—H. A. Gossard
"Some Old New Phases of Bee Disease"—E. F. Phillips
"Preliminary Notes on the Value of Winter Protection of Bees"—J. H. Merrill
"Beekeeping in the California National Forests"—G. A. Coleman
"Sweet Clover as a Bee Pasturage"—G. G. Ainslie
"Arsenical Poisoning of Bees"—W. A. Price.

The 1920 meeting also had a night session which was also an outstanding success. F. B. Paddock was Chairman and G. M. Bentley, Secretary. The program was as follows:

"Better Queens"—F. B. Paddock
"Some Apicultural Investigations"—Wallace Park
"The Problem of Controlled Fertilization of Queen Bees"—L. V. France
"The Relationship Between the Complete Life Cycle of the Honey Bee and the

Blooming Dates of the More Important Honey Plants"—H. B. Parks

"Further Notes on the Value of Winter Protection of Bees"—J. H. Merrill

"Beekeeping Problems Which Should be Undertaken by the Experiment Stations" —F. C. Pellett

"Symposium"—"Foul Brood".

PROGRAMS OF SECTION OF APICULTURE

December 29, 1921—8:00 p. m.

"The Relation of Climate to Beekeeping Manipulation"—H. F. Wilson

"Essentials to Apiary Practice and Management"—Morley Pettit

"The Correlation Between the Physical Character of the Honey Bee and its Honey-Storing Ability"—J. H. Merrill

"Time and Labor Factor Involved in Gathering Pollen and Nectar"—Wallace Park

"Bees and Nectar Flows"—H. B. Parks

"Studies on the Temperature of the Individual Honey Bee"—G. B. Pirsch

"Cost of Poor Queens"—F. B. Paddock

"Factors Affecting the Success of American Foul Brood Campaign"—S. B. Fracker.

Officers for this meeting were: H. F. Wilson, Chairman; G. M. Bentley, Secretary.

December 28, 1922—8:00 p.m.

"Relation of the Texas Agricultural Experiment Station to Beekeeping in Texas"—M. C. Tanquary

"Utilization of Various Carbohydrates as Food for the Honey Bee"—E. F. Phillips

"A Two Year's Brood Curve for a Single Colony of Bees"—W. F. Nolan

"Investigation of the Queen"—F. B. Paddock

"Value of Winter Protection for Bees"—J. H. Merrill

"Rehabilitation Classes in Apiculture"—E. N. Cory

"Temperature Reaction of the Honey Bee to Her Cluster"—L. V. France

"Legislation to Protect American Beekeeper Against the Isle-of-Wight Disease"—Rea, Fracker, Gooderham

"Isle-of-Wight Disease with Special Reference to Geographical Distribution"—E. F. Phillips.

Officers were: M. C. Tanquary, Chairman; G. M. Bentley, Secretary.

While the interest and attendance of the night sessions of the Section of Apiculture were good and increasing each year, it was thought by many of those most interested in the good to be accomplished by the papers on Apiculture that a morning or afternoon session would make it possible for more to attend if the time could be arranged not to conflict with regular program of the Economic Entomologists. The arrangement was perfected. The results in number of papers and attendance were most gratifying. Fourteen appearing with papers as shown by the following program.

December 29, 1923—10:00 a.m.

Address by the Chairman—S. B. Fracker

"Methods of Teaching Beekeeping"—Symposium.

A. "Content of the Elementary Course"—J. S. Hine

B. "Laboratory Methods"—G. M. Bentley

C. "Methods of Handling a Winter Short Course"—H. F. Wilson

D. "Research Problems Adapted for Graduate Students"—F. B. Paddock

E. "Other Preparation Needed by Those Majoring in Beekeeping"—F. E. Millen

"The Honey Bee as an Agent in the Pollination of Apples, Pears and Cranberries"—Ray Hutson

"Seasonal Variation in Brood Population"—W. J. Nolan

"Notes on Fall Feeding"—F. B. Paddock

"Storing and Ripening of Honey by Honeybees"—Wallace Park

"Temperature Changes in the Hive During a Honey-flow"—J. I. Hambleton

"Spreading of Foulbrood by Un-intelligent Treatment"—E. R. Root

"The Relation of Bacillus Alvei to Confusing Symptoms in European Foulbrood"—A. P. Sturtevant

"The Status of Isle-of-Wight Disease in Various Countries"—E. F. Phillips.

The officers in 1923 were: S. B. Fracker, Chairman; G. M. Bentley, Secretary.

December 31, 1924—9:30 a.m.

"Foul Brood Diseases in Mississippi"—R. W. Harned

"The Seventh International Apicultural Congress"—E. F. Phillips

"Notes on Bee Diseases in Connecticut"—Philip Garman

"Some Things Entomologists Might Easily do to Promote Honey Production"—Kenneth Hawkins

"Physiological Factors Affecting the Development of the Brood Diseases of Bees"—A. P. Sturtevant

"Brood Rearing Studies"—J. H. Merrill

"The Quantitative and Qualitative Effect of Weather upon Colony Weight Changes"—J. I. Hambleton

"The Sense of Smell as a Factor Enabling the Bee to Locate Pastures"—W. A. Price

"Federal Cooperation in Apiary Inspection Proposed"—S. B. Fracker

"Brood-rearing Determination"—W. J. Nolan

"Inspection Methods in Different States"—Symposium.

Chairman, R. W. Harned—Secretary, G. M. Bentley.

December 30, 1925—9:30 a.m.

"Research in Apiculture"—R. L. Webster

"Investigation Directed to the Honey Market"—E. W. Atkins

"The California Buckeye and Its Relation to the Hive Bee"—G. H. Vansell

"Chronological Distribution of Bee Moth"—F. B. Paddock

"Experiments in Attracting Queen Bumblebees to Artificial Domiciles"—T. H. Frison

"Braula coeca"—Virgil Argo

"More Knowledge Needed Concerning the Diseases of Adult Bees"—C. P. Dadant

"The Use of Water-Soap-Formalin Solution for Disinfecting American Foul Brood Combs"—G. H. Vansell

"The Cornell Beekeeping Library"—E. F. Phillips

"Apiary Inspection in Pennsylvania"—Green and Hadley

"Nectar Carriers versus Water Carriers"—O. W. Park

"Symposium—Spraying and Dusting of Fruit Trees and their Effects upon the Honey Bee"—Leader, F. C. Pellett.

Chairman, R. L. Webster—Secretary, G. M. Bentley.

The meeting in 1926 was characterized by an afternoon and evening session, both well attended.

December 29, 1926—1:30 p.m.

"The Need of a National Beekeepers Organization"—J. I. Hambleton

"The Five Year Brood Record of a Single Queen"—W. J. Nolan

"Waxworm Fumigation Experiments"—F. B. Paddock

"Federal Honey Grading Rules"—E. L. Sechrist

"Studies on the Evaporation of Nectar"—O. W. Park

"Effectiveness of the Area Clean-up Method for American Foul Brood in Tennessee"—W. L. Walling

"The Present Status of Sterilization of American Foul Brood Combs"—A. P. Sturtevant

"The Fertilization and Hibernation of Queen Bumblebees under Controlled Conditions"—T. H. Frison

"Gaseous Chlorine as a Disinfectant for American Foulbrood"—Ray Hutson

"Certain Phases of Apicultural Research in the United States"—J. I. Hambleton

December 29, 1926—8:00 p.m.

"Some Things I Saw and Heard While Visiting Beekeepers and their Societies in Europe in Summer of 1926"—E. F. Phillips.

Chairman, J. I. Hambleton—Secretary, G. M. Bentley.

The 1927 meetings were held in afternoon and evening to avoid conflicts with important meetings.

December 28, 1927—9:30 a.m.

"Disinfecting Combs"—G. L. Jarvis

"Colony Population"—W. J. Nolan

"Crop Failure"—J. M. Robinson

"Marketing Honey"—G. E. Demuth

"The Pathogenic Effect of the Mite, *Acarapis woodi* Hirst, on the Thoracic Tissues of the Honeybee"—E. J. Anderson

"Symposium—Progress Reports in Apicultural Research"—Leader, J. I. Hambleton

December 27, 1927—3:00 p.m.

"Undergraduate Courses for Apiculture Specialists"—F. E. Millen

"The Cause of Fermentation or Souring of Honey"—G. E. Marvin

"Some Points in Handling Honeybee Packages, Both in Shipping and Installing Them"—Morley Pettit

"The Amoeba Disease of the Honeybee in the United States"—J. W. Bulger

"Area Clean-up of Foulbrood"—F. E. Millen

"New Diseases of Honeybees"—C. E. Burnside

Chairman, F. E. Millen—Secretary, G. M. Bentley.

December 29, 1928—9:30 a.m.

Address of the Chairman—H. F. Wilson

"The Presence of Wax-globules as a Cause of Cloudiness in Honey"—E. L. Sechrist

"The Effect of Color Classification on the Domestic and Foreign Market"—J. I. Hambleton

"The Yeasts of Honey and How they are Carried by the Honey Bee"—Wilson and Marvin

Preliminary Report on Formaldehyde Gas Treatment of American Foul Brood Combs"—C. E. Burnside

"The Respiratory Exchange of the Honey Bee"—G. H. Vansell

"Brood Rearing Cycle of Carniolan Bees"—W. J. Nolan

"Weather and its Influence on Changes in Hive Weight"—J. A. Munro

"The Effects of Moving Bees at Orchard Blooming time"—Ray Hutson

"Definition of a Commercial Beekeeping Region"—E. F. Phillips

"The Influence of Humidity upon the Sugar Concentration of the Nectar of Various Flowers"—O. W. Parks.

Chairman, H. F. Wilson—Secretary, E. N. Cory.

This brings our history and activities up to our present meeting here at Des Moines. The progress through the 18 years has been marked with success. The Section has had the effect of standardizing the apiary inspection service in the States; it has brought the beekeepers and inspection officials together; it has stimulated apicultural research and it has been the means of bringing much of this research to those especially interested in apiculture.

BEE HIVE TEMPERATURES

By Geo. H. Vansell, *Davis, Calif.*

Abstract

Partial summary of hive temperature observations from Davis, California. Special winter protection appears extremely valuable from the standpoint of pollenization but of little use in honey production locally.

The records from which these notes are taken were made at Davis, California, in part as a comparative check between bees in California, where winter protection is looked upon as impractical, and those under colder conditions, studied earlier by Phillips and Demuth, Gates,

Wilson and Milum, and Dunham. Winter hive temperatures were recorded for packed and unpacked colonies. Records were also made under summer conditions. Thermacouples and Bristol recording

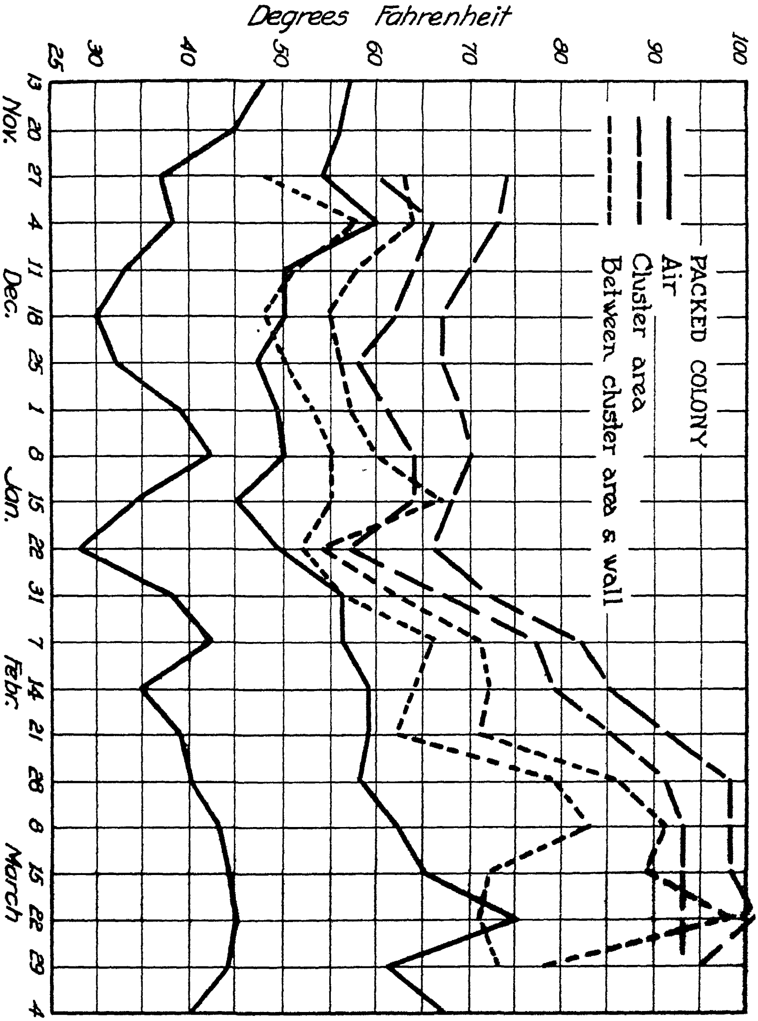


Fig. 44.—Maximum and minimum temperatures for colony packed in planer shavings.

thermometers were used. Attempts were made to ascertain the practical value of winter protection for both pollenization and honey production.

The usual brood nest temperature was near 95°F. although 100° was often reached in the packed colonies even as early as the middle of March. During the broodless period from November to January

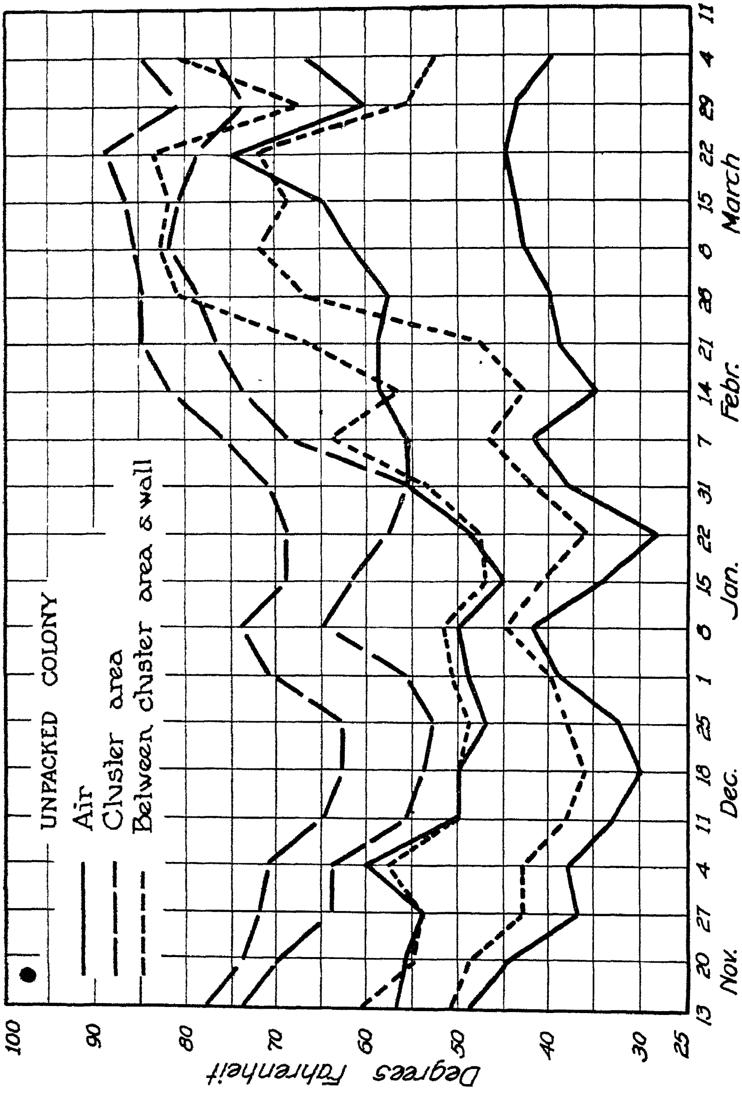


FIG. 45.—Maximum and Minimum temperatures for unpacked colony.

the minimum record was 51°F. for the bee cluster with no hive packing when outside temperature lowered to 26°. Between the cluster and the hive wall the minimum was 35°. In comparison, the cluster and

hive minima were 62° and 47° for colonies packed in planer-shavings. When the air temperature rose to 116°F. in summer, the brood nest of a colony in the sun reached 108°.

Figures 44 and 45 picture temperature conditions (maxima and minima) averaged into seven day periods for the time indicated. Effects within the hive of varying air temperatures are thus made visible. Little variation is noted in the packed colony, a desirable condition for wintering bees.

At this location, the bees wintered with special protection were nearly twice as efficient for pollenization purposes, if the counted number of individuals issuing is a safe index. The entire population of an unprotected colony was often required in the hive for brood warmth during chilly days of fruit blossoming time, while many bees were available for field work from those packed. No special increase in honey production by packed colonies was noted.

REFERENCES

PHILLIPS, E. F., and DEMUTH, G. S. Temperature of Honeybee Cluster in Winter. U.S.D.A. Dept. Bull. 93. 1914.

GATES, B. N. Temperature of Bee Colony, U.S.D.A., Dept. Bull. 96. 1914.

WILSON, H. F., and MILUM, V. G. Winter Protection of the Honey Bee Colony. Wisc. Ag. Exp. Sta. Research Bulletin 75. 1927.

DUNHAM, W. E. Relation of Heat to Brood Rearing. Gleanings in Bee Culture. *57*:359–362. June, 1929.

MR. PHILLIPS: Some years ago in southern California Mr. Demuth and I were out there and we looked into the honey flow in relation to strength of colonies and in the orange region, it very frequently happens that at the opening of orange fruit bloom there are from two to four frames of brood. The bees are totally unable to take advantage of the nectar secretion of the citrus in California. I said what a pity your colonies are not in good shape to gather next week. He laughed. "Those bees will build up on orange and gather me an average of 40 pounds of surplus, they can build up on orange and gather a surplus from sage. What more would you want?" Mr. D. said, "It will take 200 pounds of orange honey." Bees need packing in southern California. There is no part of the world where winter packing is more needed.

MR. FREEBORN: It should be remembered that this is a locality study and at Davis our only nectar flow in the early spring is from the flowers of the apricots, plums, almonds, and peaches. Mr. Vansell is sure they do not make surplus honey. It is extremely important that they have a strong colony on hand. They depend more on bees for pollination than for honey. Colonies are usually rented for such months.

THE BEE MOTHS

By F. B. Paddock, *Ames, Iowa*

ABSTRACT

These are very ancient pests of the apiary. Their systematic history is interesting. Now the distribution is quite general and of considerable economic importance. The life history and food habits are distinctive for the two species. Natural factors in control are lacking and artificial methods are ineffective.

The beemoths (*Galleria mellonella* Linn. and *Achoria grissella* Hub.) constitute one of the hazards of the honey producing industry. Their ravages have been recognized by beekeepers from early times. Their destruction while never disastrous is never the less constant and considerable. The moths are general in distribution, they seem to survive in almost any climate and are not menaced by predaceous enemies or parasites. Methods of artificial control seem to be wholly inadequate to cope with these pests, serving merely as a means of temporary check.

Historical. The very earliest records of beekeeping indicate the presence of the greater moth in the apiaries and the destruction caused by it. Virgil in his writings on agriculture refers to the moth but it is evident that there was confusion between the insect loss and that caused by disease. Insects at this time were referred to as Tiniae. The Roman writer on agriculture, Columella, at the beginning of the Christian era tells of the loss to beekeepers by moths, then called Papilio. It seems this term was applied at that time to the adult stage of all moths and butterflies. Pliny also wrote of the depredations of Papilio in the bee hives.

Samuel Purchas writing in 1657 reviews the early history of the greater moth and records some of the points of life history. Reaumur called attention to the destructive powers of the moth. He classified this moth as a false moth in contrast to the true moths, of which the clothes moth was used for example. He says the papilio of the wax moth is of the tribe *Phalaenae*, "who fly at night and burn themselves in the candle." He further makes a definite statement concerning the lesser, as follows: "There are two sorts of these caterpillars who devour wax but I shall speak only of the more common, the larger." Linneus in his tenth edition in 1758 placed the greater moth as *Phalaena mellonella* but he does not list the lesser. Four years later Modeer in discussing the diseases and pests of the apiary in Sweden refers to *Phalaena mellonella*, and in 1764 Blom also of Sweden calls the moth of bee hives *Tortrix cereana*. The greater moth was mentioned by economic writers throughout Europe but no distinction was made to indicate the presence of the lesser. Fabricius in 1793 lists also the lesser moth in his System

of Entomology and in 1818 Hubner established the present generic position. In his System, Fabricius set up the genus *Galleria* to contain *mellonella*.

It is interesting that these two species of early insects should have attracted so much attention from both economic and systematic workers. Both species were early recognized as destructive, both without close relatives and both finally placed in restricted genera for their special benefit. There was considerable confusion among the early workers for there is a rather long list of synonyms, the most part in regard to the species name. The genus *Galleria* stands today with only the single species of *mellonella* representing it and in the same family, closely related, is the genus *Achroia* with only the species *grisella*. Forbes places these and four other genera in the sub-family *Galleriinae* of the family *Pyralididae*.

Distribution. It may be said that the greater moth has a world wide distribution for it seems to be generally present wherever bees are kept. A few restrictions have been noted in regard to altitude and perhaps climate in the British Isles. It is interesting to trace the modern spread of the greater moth as into South Africa, Australia and New Zealand where rather definite dates of introduction are established. The lesser moth has a reputed world wide distribution but such a statement may need modification in details, especially until more definite information has been secured. This is made difficult because the species are not always identified so that the presence of moths may indicate one or both species. It would seem from the evidence obtained thus far that the lesser does not exist in the restricted areas of altitude and if it is in the new territory the introduction is very recent. There is no reason to expect that any territory will remain free from the lesser moth.

Life History and Food Habits. This confusion in the identification of the two species by the layman is due to the close association of the two species. Outside of the fact that both species persist in connection with bee hives there is not much common in their food habits or life history. The greater moth seems to establish itself first in an area, gaining entrance to the hives of weak colonies and thriving in the unused portions of the brood nest. The eggs are laid on the comb, on the underside of the thicker edge of the cell rim. Thus it escapes detection by the bees. The larva is extremely small but can gain entrance to the comb by at least two methods; it may come out on the rim of the cell and burrow toward the center of the comb in the area

between the cell walls, or it may eat directly through the cell wall and then towards the midrib in the fashion of leaf miners working between the two surfaces of a leaf. During this period the larvae are safe from the attacks of bees. A web tunnel is constructed wherever the midrib is eaten which serves as necessary protection. This tunnel construction follows closely on the destruction of the midrib. The cell walls are not disturbed until the midrib is destroyed then the larvae work toward either surface of the comb. During this period silken webs serve as protection with the old tunnels available in case of extreme need.

The actual food of the greater worm is still not completely defined. The earliest writers considered that this pest actually consumed the honey after the period when it was realized that the worm did not cause the actual destruction of the bees. Purchase in 1657 says, "The moth with her mealiness somewhat offends the bees, but except the hive hath few bees, or be altogether empty, she doeth no great harm." Reamur in 1744 writes of "the caterpillars who devour wax." "In order to strengthen the galleries adds fragments of wax." Huish in 1817 says, "The food of the larva is not wax but pollen and other such as bee cocoons. Pure and clean wax is never attacked by the moth, it is not found on new combs but most often attacks refuse. It gnaws wax but does not eat it." The early observations were right on the whole. The greater moth does not seem to be able to exist on pure wax or foundation. There is a decided preference for the brood combs with extracting combs serving as a second choice. The larvae do not appear to consume pollen for in new and light brood combs the tunnels seem to avoid the cells of stored pollen. It seems quite probable that they do prefer all brood cells, perhaps for the refuse but such food is not essential. In an early infestation particles of wax may be found on the outside of the tunnels and in the refuse under the combs, but when the infestation becomes excessive all of the refuse is reworked for every particle of wax.

The lesser moth usually appears after the greater has been established in an area. It does not seem to wage any fight to become established in a hive, in fact it often does not appear in ruins until after the greater has completed its work. Under natural conditions it seldom attacks combs, acting more as a scavenger, existing from the refuse accumulated by the greater. It has been taken from combs that were covered with an extremely heavy mould and apparently the greater larvae had passed up such combs. After an infestation of greater moth has been conquered the work of the lesser is soon visible. A

healthy infestation of lesser was taken from a sample of slum gum obtained from a foundation factory. It would seem that such material would not contain much food and in fact it had not been infested by the greater over a period of five years. A frame of partly drawn queen cells was attacked by the lesser moth at the Laboratory. The destruction by the lesser is most noticeable in pure wax. It will attack blocks of pure wax stored for shipment to the foundation mills, and it will readily attack exposed foundation. It has been considered a pest of stored section honey for years. Here it consumes the caps, which are of purest beeswax, and the honey runs from the cells, causing "leaky honey." It is reported by Forbes to "feed on dried apples, raisins, crude sugar, and apparently also dried insects." Experiments are now in process to check this list of foods. Such a wide range of food would prove interesting and would complicate the control problem.

Economic Importance. The loss caused by bee moths has been considered a serious handicap to honey production since the earliest times. It has never been possible to establish an actual loss for so many beekeepers have little information on their operations. It is true that weak colonies are usually attacked and such colonies have no great value. But the wax or combs destroyed in such colonies is just as valuable as the combs of strong colonies and would produce as much if the beekeeper would manage better. In this sense it cannot be said that the bee moth is a scavenger. The probable relationship of bee moth activities to the spread of disease among bees is being studied and it is hoped results will be available in the near future. The loss of combs in weak colonies must be a big factor and the loss of stored combs, either brood or extracting is much more than is appreciated by the producers. The destructive power of the greater moth is enormous, six or eight larvae will render a comb unfit for colony use, either for brood chamber or super. These pests remain ever present and a constant handicap to production.

Control. The natural factors of control have been ineffective with the bee moths. Climate, in the large sense, seems to have been a restricting factor. Altitude is considered the reason why areas of Austria, Hungary, Sweden and the Rocky Mountain region of the United States are free from this pest. There is evidently some factor of climate, perhaps excessive dampness, which holds the pests in check throughout Great Britain. These factors have served as natural checks with a few other pests in areas over the world.

It is especially interesting to have a pest of such antiquity as the beemoths, so free from predaceous enemies and parasites. Literature

records no enemies of any stage of either species of beemoth. One correspondent has recently indicated that the common field cricket probably fed on the larvae of the greater moth. Spiders have been reported as feeding on the greater larvae. If both of these enemies were actually operating it must be on a restricted basis and they certainly do not serve as an economic factor of control. Ten species of parasites have been reported on the greater moth larvae, the only stage of either species to be attacked. The parasites occur evenly distributed in three families and with one exception are primary parasites. However, these parasites are common on other species of economic pests, with one exception. Only three species of the recorded parasites are known to occur in the United States, at widely distributed areas and never have become established at any point.

Fumigation has been used as a means of combating beemoths for over 200 years. During that period practically every common material has been tested for its effectiveness in killing all stages of pests. These materials have met with varying success, depending on the environment. The problem of fumigation is associated with stored combs, both brood and extracting, and stored section honey. This means that the major part of fumigation is given during times of the year when only moderate temperatures prevail. One fumigation is given during the fall and another during the spring, with very little work during the summer and none during the winter.

Experiments have been conducted recently to determine the effectiveness of some of the newer materials and to check further on some of the older materials. The results of these trials covering a period of two years indicate some of the difficulties which are involved in the fumigation of combs in stacks of bodies or of supers. Temperature is a factor of prime importance for all fumigants lose their effectiveness at temperatures usually prevailing at time of customary treatment. Para was not effective below 75°, carbon bisulfide is only partially effective at 71° and calcium cyanide was not fatal at 70°. With a stack of even six Langstroth hive bodies a relatively high, slender container is given for fumigation. Many of the gases are heavier than air, so fall rapidly to the bottom of the enclosure, usually remaining there until dissipated. Therefore a killing concentration is not effected in the upper bodies of the stack. When bodies are piled in the ordinary manner there is considerable leakage at each joint which totals a relatively high per cent of loss of fumes during the dissipation of the material so that it is difficult to attain a lethal concentration under practical conditions.

There are then three factors, often working together, any one of which could account for unsatisfactory results in moth fumigation. In view of these considerations it will be necessary to rearrange the program for comb fumigation. The work should be planned effectively early in the fall and with temperatures much below 90°F, it will be necessary to increase the dosage of materials used. If an effective kill is obtained in the fall combs should be safe until spring when reasonable temperatures again prevail. It may be necessary to use lower stacks of combs for fumigation and extreme care must be used to have the stack more confining to gas, even if it is necessary to cover the joints.

Repellents offer a valuable aid in protecting combs from moths. Para is especially effective during the portion of the year when low temperatures prevail. It is a practice in Russia to dip combs in a strong salt solution before storage. These combs are soaked in water in the summer before using. This custom is considered practical over there but probably would not appeal to the producers of the United States. Experiments are under way now to determine the effectiveness of this practice as repellent to the bee moths.

More effective measures of artificial control are necessary to reduce the ravages of these insects. The factor of strong colonies in the yard is less effective so long as the insects can persist in liberal numbers in stored combs. It is in this part of the campaign that more definite results must be obtained and it is in this part that all factors can be controlled by the producer.

MR. MARVIN: I want to stress the effect of dampness. That seems to show some effect in Wisconsin as the moth is scarce around Milwaukee.

MR. PHILLIPS: I have been interested in wax moths for a long time, but have never done any work with them. They are not one of our outstanding pests, as Professor Paddock will agree. They are not in the same class with our disease problem. Wax moths being abundant offer opportunity for physiological work and I am glad to know he is working along that line. Some experiments have been made along this line in the U. S. Bureau. Wax moth larvae put in petri dishes in bee hive and the larvae put on cells of pollen grew until ready to burst. These things looked like pigs just before butchering. If they were put on comb foundation or on pure beeswax no growth occurred however. They kept nibbling away, but kept getting smaller instead larger. Some of us have seen the exhibits at meetings of another species of insect which in the absence of food keeps getting smaller and moults in order to become smaller.

MR. MILUM: The same applies to carpet beetles, which may be kept in bottles for several months without food and grow smaller and smaller. There are 13 moults in clothes moths. They gradually get smaller and smaller.

STUDIES OF METHODS USED TO DETECT HEATED HONEYS

By G. H. VANSELL, *Associate in Entomology, and* S. B. FREEBORN, *Associate Professor of Entomology, Univ. of Calif., Davis, Calif.*

ABSTRACT

1. "Overheated" honeys have been detected by the absence of active diastase and the Fiehe test which measures the amount of hydroxymethyl-furfural.

2. Diastatic activity is apparently dependent on the amount of pollen present in the honey and the absence of pollen may be the cause of condemning some honeys as overheated, such as navel orange and alfalfa.

3. Heat produces a furfural reaction in honey but the same reaction may be produced without heat by 30 minutes contact with concentrated HCl.

4. Storage or possibly crystallization play important roles in producing positive furfural reactions, particularly in extracted honeys, if sufficient time is allowed.

5. The Fiehe reaction is not a reliable test for overheating nor is the diastatic activity, unless the pollen count is taken into consideration.

The application of heat to extracted honey produces chemical changes that progress as the heat or length of exposure is increased from an undetectable state to the point where the honey is caramelized and decidedly undesirable. Theoretically, therefore, any honey that has been exposed to more heat than it would normally experience in the comb is a changed product and becomes something other than natural honey. This attitude has been adopted by one European country with the result that many shipments of American honey have been condemned as "overheated."

The methods used to detect heated honeys have been based on two known facts. First, heating destroys the diastatic activity, and second, heating of levulose produces furfural derivatives. Consequently, if active diastase is absent and furfural derivatives are present in small amounts (larger amounts suggest adulteration with commercial invert sugar), the honey may be declared to be overheated and cannot be marketed as table honey.

DIASTASE REACTION. Numerous methods based on the reduction of soluble starch solution by the enzymatic content of the honey have been utilized for the measurement of the diastatic activity. In some of these, the amount of honey necessary to reduce a given amount of starch in a unit of time has been used while others have utilized

the time required for a given amount of honey to reduce a given amount of starch at a stated temperature. The official German test is made by merely adding honey to starch solution and passing or rejecting the honey tested on the basis of whether the starch was reduced or present at the end of an hour's exposure at 37°C. Later refinements have been the rapid alcoholic extraction of the enzyme from the honey and the standardization of this washed extract to pH 4.4 in order to avoid contamination from the honey and insure a satisfactory working medium for the diastase. Considerable doubt has been thrown on the value of the diastase reaction by Vansell and Freeborn,[1] who have shown that the diastatic content of honey is caused by its contamination with pollen and is not a product of the bee's metabolism. They have also shown that normal comb honeys, for instance navel orange and alfalfa may be so lacking in pollen that the honey when tested is deficient in diastase and hence would be condemned as "overheated." California exporters familiar with this work have limited their examinations to the Fiehe test, an examination for the presence of hydroxymethylfurfural.

FIEHE TEST. When the levulose in honey is heated in the presence of an acid, a slight amount of hydroxymethylfurfural is produced. The presence of this material is then used as an indication of heating and the honey showing a positive reaction is condemned as overheated. Again in this test many modifications have been introduced. The test now in use in Germany was kindly supplied us through the courtesy of Mr. Leslie E. Reed of the American Consulate at Bremen, and is as follows:

> Five grams of honey are ground and dissolved in a mortar with pure ether which has been stored over metallic sodium. The ether extract is then poured into a small porcelain dish. After the evaporation of the ether at ordinary temperature, the residue is moistened with a newly prepared solution (or with one which has been stored in a place without light) of one gram of resorcin in 100 grams of *hydrochloric acid* of a specific gravity of 1.19. A strong cherry-red color lasting *at least one hour*, indicates the presence of artificial invert-sugar, whereas a weak, quickly disappearing orange-to-pink coloring might be the result of overheating.

This test is designed primarily for the detection of commercial invert sugar as an adulterant of honey, but a slight reaction not pronounced enough to indicate adulteration is considered to indicate

[1]Vansell, G. H. and Freeborn, S. B.—Preliminary Report on The Investigations of the Source of Diastase in Honey. JOUR. ECON. ENTOM. *22*:922–926. 1929.

heating. Lampitt, Hughes, and Rooke[2] have carried on the most extensive work yet published on the factors effecting this reaction and fail to find a single honey that showed a positive Fiehe reaction until enough heat had been applied to materially change the color of the honey and caramelize it to the extent that its flavor was decidedly affected. In this paper they point out the fallacies of the original technique of the Fiehe reaction together with those of its various modifications. Our observations check with those of the authors just mentioned whenever we used freshly extracted honey. However, with extracted honeys from one to three years old that had been allowed to crystallize, a positive Fiehe test (German method) was obtained in every instance before any heat was applied. Whether this idiosyncrasy was a result of storage alone or of crystallization it is difficult to say and a check on these findings rests with subsequent tests of extracted honeys. that are now negative at a later date after they have crystallized.

Crystallization is a purely physical phenomenon and it is difficult to believe that this process alone could be responsible for the change in reaction. However, it must be borne in mind that when a honey crystallizes, the levulose concentration of the material *in solution* increases from approximately 40 to more than 60 per cent, and it is assumed that the acid content of the solution also increases. This is caused, of course, by the elimination of the dextrose from solution. Given this greater concentration, the process of furfural formation may be accelerated. The absence of heat may have been compensated by the length of time required to produce the furfural in our samples. Heat merely accelerates the chemical reaction that proceeds slowly but just as surely in its absence.

In this connection it is worth pointing out also that differences in time required to complete the reaction may be somewhat dependent on the ratio of levulose to dextrose. It would be expected that a honey high in levulose might show a positive Fiehe reaction before one low in levulose in spite of the fact that neither had crystallized. In addition, the amount of acid present which acts as a catalyst in producing furfural derivatives, influences the reaction. We were able by adding one drop of concentrated hydrochloric acid to a 5 gram sample of alfalfa comb honey that was normally negative to the Fiehe test to produce after 30 minutes a positive Fiehe reaction. This was repeated several times with different honeys with the same result. It should be noted that no heat was required in these instances.

[2]Lampitt, L. H., Hughes, M. B., and Rooke, H. S.—Furfural and Diastase in Heated Honey. The Analyst, *54*:381-395. 1929

If, therefore, a positive Fiehe reaction can be produced in a normally negative honey in 30 minutes by the addition of a drop of concentrated hydrochloric acid without the intervention of heat, is it not feasible that the same reaction may proceed in nature with a weaker acid if sufficient time is allowed, particularly if the acid and the levulose, the chief source of the furfural derivatives, are concentrated by dextrose crystallization.

It would appear from the foregoing that except for freshly extracted honey that the Fiehe reaction is a faulty test for heating. The test for diastatic activity also fails to be trustworthy unless a pollen count is made of the sample. All pollens vary in their content of diastase but in our trials a count of at least 3000 pollen grains per gram was found to be the absolute minimum sufficient to produce enough diastase to enable the sample to reduce the required amount of soluble starch. A negative diastatic reaction and a pollen count in excess of 3000 grains per gram is trustworthy evidence of overheating.

PHILLIPS: I have been tremendously interested in California experiments, on diastase, because it tends to make me feel a little more comfortable about my own findings. Two other investigators have reported that diastase is normal in the alimentary canal.

In attempting to determine the carbohydrates in honey bees including soluble stages it was found in the work at the Bureau that there was no prolongation of life and no modification of starch. The iodine test was used and these were checked by means of testing the enzymes with the same result. It is further unfortunate that the Germans have applied tests to imported honey, which are not universally applied in their domestic honey. Heat is applied in Germany as well as here before bottling. We would have no right to complain of a requirement in imported honey in their country if they applied the same requirement to ours.

FURTHER OBSERVATIONS ON THE DETERIORATION AND SPOILAGE OF HONEY IN STORAGE

By GEORGE E. MARVIN, *Madison, Wis.*

ABSTRACT

Honey deteriorates after being extracted from the combs and the time of extracting and conditions under which honey is stored affect the rate of change. Fermentation, caused by sugar tolerant yeasts, is one cause of deterioration. When honey granulates, conditions are brought about which are conducive to the growth of these organisms. Carbon dioxide, rarely over 5% alcohol and a non-volatile acid are the byproducts of fermentation which cause the off flavor to fermented honeys.

Honey, which is to be sold in small containers, should be heated to 160°F., pailed and sealed while hot to prevent fermentation. The honey should then be cooled down suddenly for if held at high temperatures for some time, it will become slightly darkened. Honey in storage which has never been heated should be kept at temperatures below 52° F. to prevent fermentation and color changes.

Introduction

Contrary to a general belief that honey will continue for long periods without deterioriation, we have found at the Bee Culture Laboratory of the University of Wisconsin that honey deteriorates rapidly after being extracted from the combs and that the time of extracting and conditions under which it is stored, affect the rate of change.

It has long been considered best to keep honey at warm temperatures, but we believe, from the results of our investigation, that extracted honey should be stored at low temperatures to prevent color changes and to prevent fermentation while the honey is in storage. Honey darkens with age and the higher the temperature, the more rapid the color change.

In commerce these color changes are slow and seldom serious unless for some reason it is necessary to hold shipments for more than two seasons. However, another factor enters into the problem of honey storage and that is fermentation which frequently causes much loss on the part of beekeepers and bottlers in all parts of the United States and Canada.

It is now a well known fact[1] that honey fermentation is caused by yeasts, capable of developing in high concentrations of sugar as are found in honey.

When fermentation occurred, it was formerly considered that the honey had been extracted before being thoroughly ripened by the bees. In our studies we have found that yeasts are present in most natural honeys and when granulation occurs, conditions are made favorable for their multiplication.

Source of Yeasts. The starting point of our original experiment was with four samples of fermenting honey, all coming from Wisconsin. The honeys were put in class containers for observation. All of the samples had a soft granulation. Soon they became plainly divided into a lower granulated layer and an upper fluid layer with the surface covered with foam.

The odor reminded one somewhat of the bouquet of a sweet wine or fermenting canned fruit. Under the microscope one could observe

[1]See Bibliography.

yeast cells. As fermentation progressed, the fluid layer became greater and the granulated layer retreated.

Samples of these honeys were plated and yeasts grew in large numbers. (4) Five seemingly different types of colonies were taken from the plates, transferred to slopes and so the starting cultures for the experiment were secured.

Since the beginning of our honey fermentation work, we have received and have worked over samples of honey from California, Florida, Ontario, Quebec, Ohio, Kentucky, Maine, Illinois, Utah, Connecticut, Colorado, Hawaiian Islands, Porto Rico and Norway. We have isolated over 50 pure cultures of yeasts. There is still a tremendous amount of work to be done in classifying these yeasts.

EXPERIMENTAL. The yeasts used in this work were obtained by plating fermenting honey on honey yeast-water agar and from isolated colonies, transfers were made to fresh honey yeast-water agar slopes.

Yeast water was used to dilute the honey in the fermentations and the diagnostic sugars were dissolved in it. It was prepared by suspending starch free yeast in ten times its weight of water, steaming for two hours and sterilizing at 15 pounds pressure for two hours.

Diagnostic sugars were prepared by dissolving approximately two grams of the various sugars in 100 cc of yeast water. Ten cc were put in test tubes which were plugged and sterilized and on cooling were inoculated with the various honey yeasts. Care was taken in sterilizing the sugar media in order to avoid any decomposition of the sugars. The sugar present in a solution after fermentation was determined by the Shaffer-Hartman method as modified by Stiles, Peterson and Fred (7).

Alcohol determination: 100 cc of the honey medium after fermentation was completed were put into a distilling flask, a small amount of dry phenophthalein and brought to neutrality. 50 cc of distilled water was added, 5 grams of Na Cl and a little Tannic acid. 100 cc of distillate was caught, cooled to 15½ degrees C. and the specific gravity determined by the Picnometer and Westphal Balance.

Titrable acids: 50 cc of distilled water was added to 10 cc of the honey medium after fermentation and brought to boiling. Phenophthalein was used as an indicator and titration continued until the first permanent pinkness appeared.

Volatile acids: to 200 cc of the honey medium after fermentation, 5 cc N/5 H_2SO_4 was added. 1000 cc was steam distilled over. The distillate was brought to boiling, phenophthalein added and titrated with N/10 Na OH.

Non-volatile acids: 100 cc of honey medium after fermentation, was extracted for four days with ether. The extraction was titrated with N/10 Barium Hydroxide.

The amount of carbon dioxide given off by each yeast during fermentation was obtained by weighing a flask of fermenting honey at intervals. The flask was sealed with a fermentation trap, the carbon dioxide escaping through H_2SO_4.

FERMENTING OF SUGARS BY HONEY YEASTS. A series of test tubes was set up, each tube containing 10 cc of approximately 2 per cent dextrose, levulose, sucrose, mannose, lactose, galactose and maltose in yeast water. The five cultures of honey yeasts were used. After 168 hours of incubation at 28 degrees C., the cultures and controls were analyzed for sugar.

TABLE 1. FERMENTATION OF VARIOUS SUGARS

(The figures after the cultures represent the grams of sugar fermented)

Sugar in Uninoculated	Dextrose	Levulose	Sucrose	Mannose	Lactose	Galactose	Maltose
Control	1.8	1.74	1.84	2.08	1.75	1.93	1.74
Culture 1....	1.76	1.67	.50	2.00	.10	.67	.77
Culture 1A...	1.75	1.67	.74	1.94	.08	.62	.52
Culture A....	1.75	1.66	.85	1.98	.08	.55	.97
Culture B...	1.77	1.66	.69	2.00	.07	.56	1.05
Culture C....	1.74	1.64	1.66	1.94	.07	.64	1.23

From the table one sees that the five honey yeasts are divided into three groups as to their ability to ferment sugars.

Group 1—Cultures 1, 1A and A. Dextrose, levulose and mannose are fermented energetically while sucrose, galactose and maltose are fermented more weakly.

Group 2—Culture B. Dextrose, levulose, mannose and maltose are fermented energetically while sucrose and galactose are fermented more weakly.

Group 3—Culture C. Dextrose, levulose, sucrose, mannose and maltose are fermented energetically while galactose is fermented more weakly.

With the Shaffer-Hartman method of sugar analysis it was impossible to find the exact amount of raffinose, melezitose, starch and dextrins that were fermented, so the following procedure was used to determine the fermentability of these substances by honey yeasts.

Ten cc of a 2 per cent solution of raffinose, melezitose, starch and dextrin made up in yeast water together with plain yeast water as a check were put in tall test tubes, plugged, sterilized, cooled and inoculated with the honey yeasts. A plug of sterile liquid vaseline

was put on the surface of the liquid, which hardened on cooling. With fermentable sugars, as the gas is evolved, the vaseline plug is pushed upward. By observing the height to which the plug is pushed, one can determine in a relative way the ease with which a sugar can be utilized by the yeast in question. With the honey yeasts, no gas was produced with raffinose, melezitose, starch or dextrin, so these materials are not fermented by the honey yeasts.

TABLE 2. RATE OF FERMENTATION PER 100 CC 50% HONEY WEIGHT OF CARBON DIOXIDE IN GRAMS GIVEN OFF

Culture	Days 1	3	6	10	13	20	27	40	Total Loss
1	—	.7	.9	.7	.7	1.1	.7	—	4.8
1A	—	.7	.7	1.3	.4	1.1	.7	.7	5.6
A	—	.7	.9	.4	.7	.9	.7	.2	4.5
B	—	.4	.7	.4	.7	.9	.7	.2	4.0
C	—	.7	.7	.7	.7	1.1	1.1	.2	5.2

Fermentation in a 50 per cent honey medium is relatively rapid compared with what it would be in an ordinary sample of honey. In the case of the latter, it requires a long time for the action to get started and it extends over a period of six months to a year. Evolution of carbon dioxide is very slow. In the 50 per cent honey medium the fermentation appeared to be over after 40 days and clearing was noticed.

The five cultures of yeast can be separated into three groups relative to ring formation in a flask of fermenting 50 per cent honey medium.

Culture A—forms a very light ring.

Cultures 1, 1A and B—form a medium heavy ring.

Culture C—forms a very heavy ring.

None of the cultures form a scum on 50 per cent honey medium, but a thick foam is usually present on the surface of the fermenting liquid when the action is at its height.

PRODUCTS OF FERMENTATION. During honey fermentation the products given off by the yeasts are carbon dioxide, alcohol and acid. Most of the acid given off is of the non-volatile type.

TABLE 3. FERMENTATION PRODUCTS FORMED PER 100 CC OF 50% HONEY

Culture	Carbon Dioxide Grams	Alcohol Grams	Tit. Acid cc N/10NaOH	Non-volatile Acids cc N/10 $Ba(OH)_2$	Volatile Acids cc N/10NaOH
1	4.8	4.4	21	19.8	1.1
1A	5.6	4.7	25	22.6	3.0
A	4.5	3.8	17	14.3	3.6
B	4.0	4.0	31	25.1	6.2
C	5.2	5.0	15	15.0	.3

Various concentrations of honey were used in determining the amount of alcohol produced by honey yeasts. In no case was the

production over five per cent. Thus, honey yeasts may be classed as low alcohol producers.

Natural Fermentation of Honey. In all of our honey work, we have observed only three naturally fermenting honeys that were liquid throughout and these samples were very thin, having a high moisture content. All of the rest of the samples we observed (around forty) were granulated or partly so but not solid. From these observations we believed that fermentation and granulation went hand in hand and perhaps granulation of honey brought about conditions which were favorable for the fermentation.

One of our early experiments was to inoculate samples of pasteurized honey with pure cultures of honey yeasts. As long as the honey remained liquid, no noticeable fermentation took place but after a year and some after two years when granulation commenced, the samples began to show signs of fermentation.

When honeys granulate coarsely a liquid forms around the crystals. Honey in this condition is easily separated and the moisture content of the liquid and of the crystals determined separately.

The moisture determination of several honeys are here given. One is a fermenting honey and the other, a heated sample of honey which granulated coarsely after a year in storage.

	Moisture	
	FERMENTED	NOT FERMENTED
	%	%
Liquid layer above crystals..................	18.33	20.8
Crystals below liquid...........................	9.39	11.75

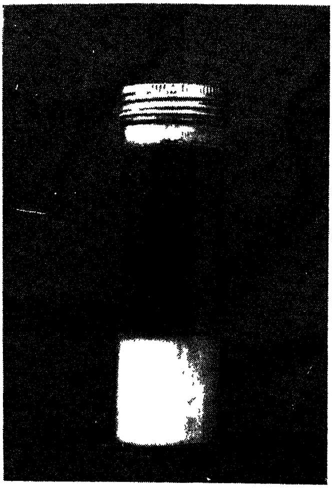
The granulation of honey explains why fermentation can take place in so-called ripe honeys. When granulation takes place, the dextrose settles out and contain less moisture than the original honey. Thus some extra moisture is given to the liquid portion of the honey which further thins it, making it dilute enough so that yeasts which are present in the honey grow.

Explanation of Plate 16

1.—A sample, showing the typical appearance of fermenting honey. The honey becomes divided into a lower granulated layer, an upper fluid layer with the surface covered with foam. See pages 436 and 437 for moisture and sugar analyses.

2.—The apparatus used for determining the amount of Carbon Dioxide given off during fermentation. The diluted honey after fermentation was analyzed for alcohol and acids.

3.—The sterile vaseline plug on the surface of 10 cc of a 2 per cent solution of raffinose, melezitose, starch, dextrin and yeast water as a check to determine their fermentability by honey yeasts. None of these substances are fermentable.



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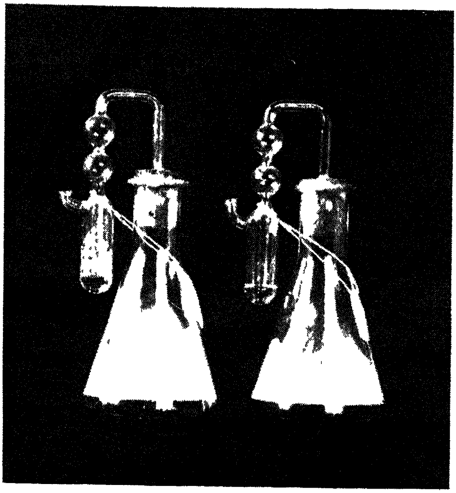

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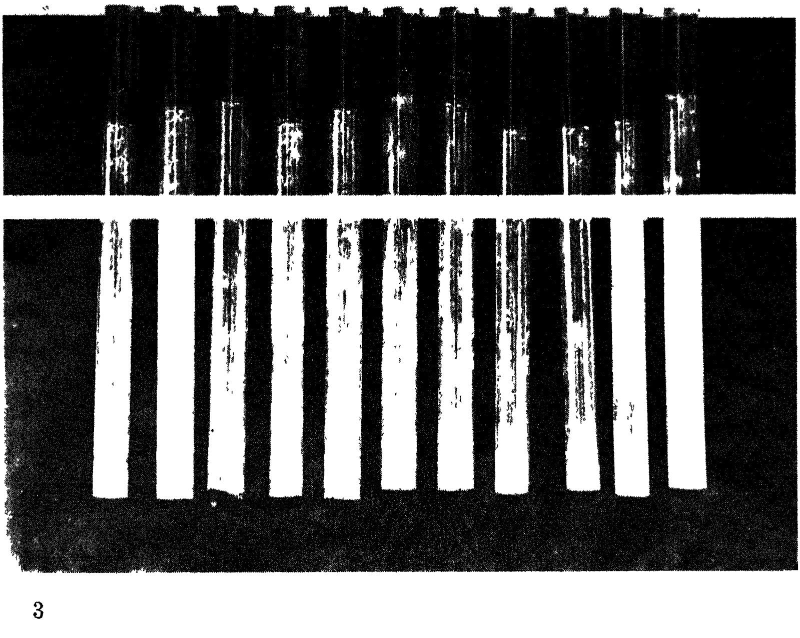


3

From previous experiments, we have found yeasts which are able to grow in high concentrations of sugar, widely scattered in nature. The spores are present in most honeys as our results show and when the proper conditions for their growth are brought about through the granulation of honey, the yeasts are able to grow and multiply. The products given off during their growth is what causes the off flavor to fermented honey.

Sugar analyses have been made of the liquid and granulated portions of fermented and unfermented honeys.

FERMENTED SAMPLE	CRYSTALS	LIQUID PORTION
Dextrose	36.78	28.37
Levulose	29.18	35.76
UNFERMENTED SAMPLE		
Dextrose	39.42	26.92
Levulose	29.14	37.50

PREVENTING FERMENTATION. In our experiments we have found that by heating honey to 160 degrees F., fermentation can be prevented. By heating honey to this temperature, the yeasts can be killed without holding the honey at that temperature for a period of time. In this case, heating kills the yeasts and prevents granulation for a year or so. Honey should be agitated while being heated so that nearest the container will not become overheated. Honey treated thusly will not be injured in flavor or color.

Unheated honey can be kept in storage at temperatures below 52 degrees F., for at that temperature yeasts will not grow and multiply.

SUMMARY. It is now a well known fact that honey fermentation is caused by yeasts. The fermentation process is slow, extending over a period of six months to a year. Carbon dioxide, rarely over five per cent alcohol and a non-volatile acid are the by products which cause the off flavor to fermented honeys.

When honey granulates conditions are brought about which are conducive to the growth of yeasts.

Honey fermentation can be prevented by heating to 160 degrees F.. or by holding honey at temperatures below 52 degrees F.

BIBLIOGRAPHY

1. NUSSBAUMER, T. 1910. Beitrag zur Kenntnis der Honiggarung nebst Notizen uber die chemische Zusammensetzung des Honigs. Zeitsch. f. Untersuch. d. Nahr. Genussmittel *20*:272–277.
2. RICHTER, A. A. 1912. Uber einen osmophilen Organismus, den Hefepilz Zygosaccharomyces mellis acid sp. n. Mycol. Centralbl. *1*:67–76.
3. MARVIN, G. E. 1927. A preliminary report on the cause of the fermentation and souring of Honey. Wisconsin Beekeeping *4*:109–110.

4. ——— 1928. The occurrence and characteristics of certain yeasts found in fermented honey. JOUR. ECON. ENT. *21*:363–370.
5. FABIAN, F. W. and QUINET, R. I. 1928. A study of the cause of honey fermentation. Mich. Agr. Exp. Sta. Tech. Bul. No. 92.
6. LOCHHEAD, A. G. and HERON, D. A. 1929. Microbiological Studies of Honey. Dominion of Canada, Dept. of Agr. Bul. no. 116—New series.
7. STILES, H. R., PETERSON, W. H. and FRED, E. B. 1926. Journ. Bact. Vol. 12: 427–439.

PHILLIPS: What was the procedure in crystal experiment?

MARVIN: I melted crystals and poured on dish of white sand and heated in electric oven until constant weight was acquired.

STUDIES ON THE SUGAR CONTENT AND YIELD OF NECTAR FROM DIFFERENT VARIETIES OF *GLADIOLUS PRIMULINUS*

By O. W. PARK, *Iowa Agricultural Experiment Station, Ames, Iowa*

ABSTRACT

Studies made upon nectar from more than 25 varieties of *Gladiolus primulinus* showed that, while the percentage of sugar in nectar from different varieties varied within comparatively narrow limits, certain varieties characteristically yielded two and three times as much nectar as did certain others.

It has long been recognized that certain species of honey plants produce more honey than others but it has not been known whether all varieties of a given species yield equally well. In an effort to throw light on this question, studies have been made during two summers on a total of more than 25 horticultural varieties of *Gladiolus primulinus*, grown in the formal gardens at Iowa State College. *Gladiolus* is not an important source of honey but it is visited freely by honeybees and, in general, is well adapted to the needs of this problem.

A considerable number of variable factors outside of the plant itself, influence the production of nectar. For the sake of brevity, these may be grouped and referred to as light, air and soil factors. Differences due to variations in light and air conditions were reduced to a minimum by collecting each group of samples within a brief period, usually lasting from 30 to 40 minutes, in the early afternoon, which is the time of day when light and air factors normally are most nearly constant. The soil factors were considered uniform for the following reasons. The same general section of the garden has been devoted to the growing of Gladioli for several years. The area involved was very limited and the relative location of the several varieties was different for the two seasons.

Differences due to variations in the plants and flowers, other than varietal differences, were overcome to a considerable extent by taking composite samples composed of the nectar from 25 individual flowers.

Four groups of samples were taken in 1928 and a similar number in o929, each group containing samples secured from 20, or more, varieties. Owing to the preliminary nature of this study, only five varieties were represented in every one of the groups, hence, only these five are considered in this paper.

In order to provide a basis for comparing these varieties, three arithmetic means were determined for each variety, as follows:

(1) Quality of nectar (per cent of sugar)

(2) Quantity of nectar per flower

(3) Sugar yield per flower

When compared as to quality of nectar, the results indicate that further data will be required before it can be determined definitely whether certain varieties characteristically produce richer nectar than others. There are indications, however, that such probably is the case, altho the differences may not be great.

The quantity of nectar yielded by the highest producing variety was just three times that of the lowest, while the production of the other three varieties fell about a point approximately half way between the extremes just indicated.

In sugar yield, the rankings were the same as for quantity of nectar except that the varieties which ranked, respectively, 2nd and 3rd in nectar production, exchanged places when compared as to sugar yield. The weight of sugar obtained from the highest producer was nearly three times that obtained from the lowest, and the yields of the remaining three varieties again fell about mid-way between the extremes.

It may be tentatively concluded, therefore, that certain varieties of *Gladiolus primulinus* yield considerably more nectar than others and that, under similar conditions, the amount of sugar produced depends to a greater extent upon the quantity of nectar produced than upon its quality. These results suggest the desirability of similar studies on other and more important honey plants. If, for instance, certain varieties of sweet clover or alfalfa should be found superior to others of the same species for honey production, a new avenue for increasing the honey crop will have been opened.

VARIATION IN THE CONCENTRATION OF FLORAL NECTARS

By O. W. Park, *Iowa Agricultural Experiment Station, Ames, Iowa*

ABSTRACT

A preliminary report on the extent to which variation has been found in the concentration of floral nectars.

Studies on more than 2000 samples of floral nectar have shown marked differences in the percentage of sugar contained The causes of such variation will be discussed in a future publication. The purpose of this paper is to make a brief preliminary report on the extent to which variation has been found in the sugar content of floral nectars. Sugar concentrations were determined by means of an Abbé refractometer.

The writer[1] has previously shown that the sugar content of nectar from a given plant species, varies from hour to hour thruout the day. While all species studied so far, appear to show this diurnal fluctuation, individual species differ as to the range thru which such variation occurs. Variations other than diurnal fluctuations, would be most readily discovered from data into which diurnal variation did not enter. For this reason, samples to be compared were collected within the shortest possible time, two persons often being engaged in collecting simultaneously. Data thus obtained form the basis for the remainder of this discussion.

Composite samples of nectar, taken almost simultaneously from a number of different varieties of *Gladiolus primulinus* growing side by side, showed some variation but within comparatively narrow limits. Further data will be necessary before a definite statement can be made on this point.

Individual nectar samples taken in rapid succession from individual flowers of a single horticultural variety of *Gladiolus primulinus*, were compared as to sugar concentration. Three groups of 30 samples each, gave coefficients of variability of 27, 28 and 38 per cent, respectively.

In order to obtain data on the variation from floret to floret of the same umbel, nectar samples from *Asclepias syriaca* were used. Ten samples, each from a different floret of the same umbel, were taken for comparison. Coefficients of variability, determined for 26 such groups of samples, showed a minimum figure of seven per cent, a maximum of 32 per cent and a mean of 14 per cent.

Thus the concentration of floral nectar has been found to vary from

[1]Park, O. W. The Influence of Humidity upon Sugar Concentration in the Nectar of Various Plants. Jour. Econ. Ent. 22:534–544. 1929.

hour to hour, from species to species, flower to flower and even from floret to floret in the same umbel.

PHILLIPS: Will you give us the color of the flowers? I wondered if the dark reds would not run higher temperatures.

PARK: No, I cannot tell you the colors. I hope to get more data on it, but am merely getting under way. I do not feel it is a proven fact yet; I simply present it as a progress report, an indication of what we are trying to do and a study of sweet clover, buckwheat and white clover.

MILUM: Has any attempt been made to take flowers at the same degree of maturity?

PARK: No.

VARIATIONS IN TIME OF DEVELOPMENT OF THE HONEY BEE

By VERN G. MILUM, *University of Illinois*

ABSTRACT

Studies made at the Wisconsin Experiment Station in 1924–1925 show variations, partly correlated to temperature, in the period from egg laying to capping of worker brood cells from less than 8 days to more than 11 days, majority being capped between the 8th and 9th days. Variations for complete development ranged from less than 19 7/8 days to more than 24 days. One set of experiments showed approximately 75 per cent of 4094 workers completing their development in less than 21¼ days. In another more definitely controlled set of 2602 individuals, 94 per cent emerged in less than 21 days with an average developmental period of approximately 20½ days.

The information herewith submitted has been taken from data secured by the writer in a study of colony temperatures at the Wisconsin Agricultural Experiment Station during the summers of 1924 and 1925, under the direction of Professor H. F. Wilson, of the Department of Economic Entomology to whom the writer is indebted for suggestions and the use of equipment and colonies. A part of the 1924 results were published in the *American Bee Journal*, Vol. 65, pp. 368–370.

In the course of a study of the temperature maintained in normal colonies under brood rearing conditions in the spring of 1923 it was found that the temperature of the brood rearing areas varied considerably from the temperature of 93°F. usually given by most writers. The records show that on April 11, 1923 none of five colonies with various types and amounts of protection had temperatures above 90.2°F., while 76.3°F. was the lower limit of the brood rearing area in a colony without any packing or protection. Although the temperatures of the brood areas generally varied between 90° and 95°F., it was

apparent that the queen often extended her egg laying activities to colder points. Temperatures from 95 to 97.5°F. were recorded but at these higher temperatures the bees were always hanging out at the entrance, indicating undesirable conditions.

With the facts just stated in mind, the question arose as to the amount of variation in the periods of the developmental stages under the extremes of temperature of the brood nests. A survey of the literature upon this question shows many differences of opinion among the earlier writers although many suggested variations depending upon the weather or temperature. In recent statements upon the subject, 16, 21 and 24 days are given as the length of time for the complete development of the queen, worker and drone honey bee, respectively. However, in none of these writings reviewed has a statement been found giving the results of actual controlled observations. Accordingly experiments with the worker honey bees were conducted during the summers of 1924 and 1925 with colonies each equipped with 44 copper-constantine thermocouples of which the temperatures could be determined by a potentiometer pyrometer. This apparatus and method are described in Research Bulletin 75 of the Wisconsin Agricultural Experiment Station.

In the 1924 experiments, frames of worker eggs were obtained by inserting brood free frames into the centers of strong colonies of bees for approximately 24 hour periods. The number of eggs laid that actually completed development as determined by counts made from photographs varied from 82 to a maximum of 803 or a total of 4094 on the nine frames used, as indicated in Figure 46. At the end of the egg laying periods these frames were inserted at definite positions in the brood nest of the experimental colonies with different degrees of protection and hence of temperatures maintained within their respective brood nest. These frames were kept surrounded with brood of all ages, to avoid neglect but the queens were confined to the upper body to prevent further egg laying.

At the time of capping of the brood the frames were removed and photographed on successive days until all cells were capped and then again at the time of emergence. In photographing, the frames of brood were taken into the warm laboratory to prevent chilling, and were photographed behind a dummy frame marked off by wires into inch squares which facilitated the counting of the individuals at a later time. Because of lack of time, the colony temperatures were usually recorded not more than once each day although at various hours. The temperatures given in the tables of Figures 46 and 47 are the averages of these

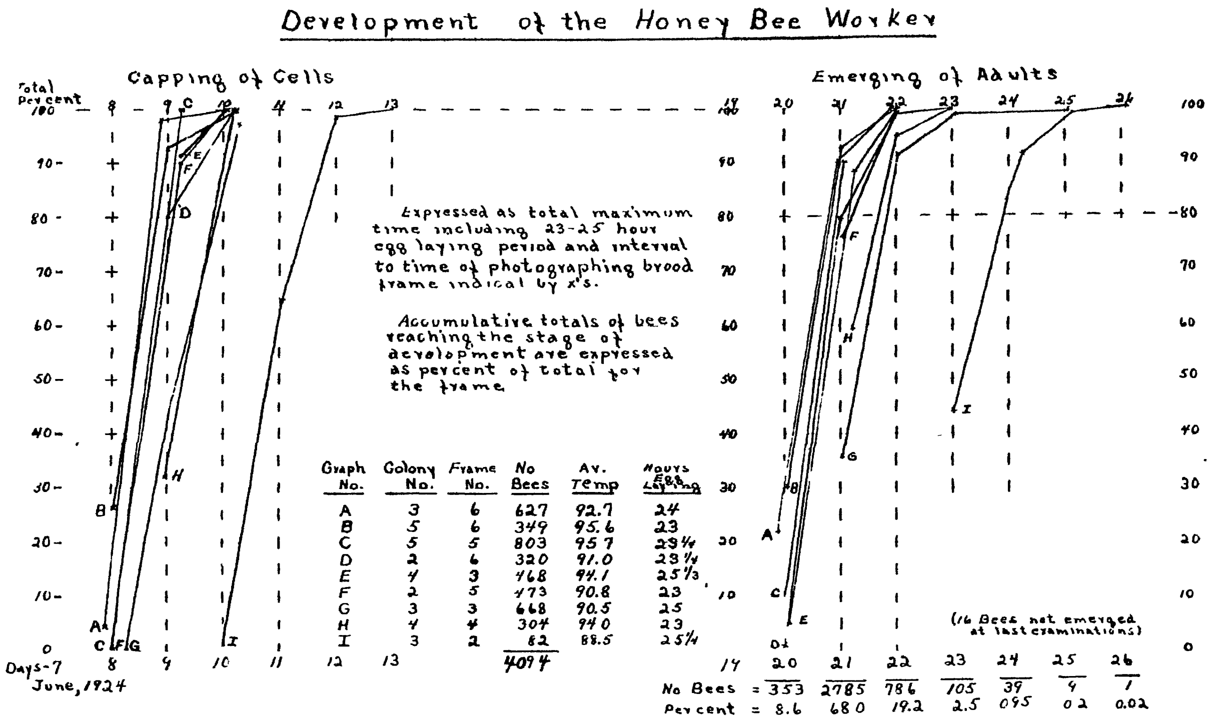

Development of the Honey Bee Worker
Capping of Cells
Emerging of Adults
Total Per cent
Expressed as total maximum time including 23-25 hour egg laying period and interval to time of photographing brood frame indical by x's.
Accumulative totals of bees reaching the stage of development are expressed as percent of total for the frame.
Graph No. | Colony No. | Frame No. | No Bees | Av. Temp | Hours Egg Laying
A 3 6 627 92.7 24
B 5 6 349 95.6 23
C 5 5 803 95.7 23¾
D 2 6 320 91.0 23¼
E 4 3 468 94.1 25⅓
F 2 5 473 90.8 23
G 3 3 668 90.5 25
H 4 4 304 94.0 23
I 3 2 82 88.5 25¼
4094
Days-7 8 9 10 11 12 13 14 20 21 22 23 24 25 26
June, 1924
No Bees = 353 2785 786 105 39 4 1
Per cent = 8.6 68.0 19.2 2.5 0.95 0.2 0.02
(16 Bees not emerged at last examinations)

FIG.—46

daily readings during the developmental periods which are probably quite relatively correct.

Figure 46 is an attempt to graphically represent the data obtained in the 1924 series of experiments. At the left the time of capping of the worker cells and at the right the time of emergence is indicated, each separate hive representing the bees on the particular frame designated by letters A to I. The information as to the colony and the particular location of that frame in the hive are given in the chart in the bottom center of the Plate. Additional information given there is the number of bees per frame, the average temperature of the thermocouples surrounding the brood during the period of development and the period of egg laying.

The accumulative totals of bees on each separate frame reaching the particular stage of development at the time the photographic records were made are graphed against the periods of time in days from the laying of the eggs which is the maximum possible time. Owing to the long period of egg laying used in 1924 (23–25⅓ hours) and the 24 hour period between most of the daily examinations the information obtained is not vert definite.

However, a study of Figure 46 will show that between 70 and 98 per cent of the bees on frames A to G were capped over in less than nine days, even counting the entire egg laying period, while on frame A, 28 cells or 4.4 per cent were capped in less than seven days and 22 hours. Many cells on Frame B were probably capped in less than eight days since 26.3 per cent or 92 cells were sealed before a maximum time of eight days 1½ hours. On the other hand with frame I, only one cell had been capped at the maximum of 10 days and the last cell of 82 on the frame had not been sealed at the end of 12 days and 15 minutes. Even if this particular egg were laid at the end of the egg laying period, it could not have been capped in less than 10 days and 23 hours.

For the maximum time required for emergence of adult worker the graphs at the right of Figure 46 show that 8.6 per cent of the total of 4094 bees emerged in less than 20 1/12 days, while an additional 68 per cent had emerged in a maximum period of less than 21¼ days. With frame A, of a total of 627 bees, 137 or 21.8 per cent actually emerged in less than 19⅞ days. With frame I with an average temperature of 88.5° F. no individuals had emerged in 22 days, while the last bee required at least 24 1/12 days.

Further experiments were conducted in 1925 along the same lines, but the period of egg laying was reduced to exactly six hours, the number of eggs obtained on the 11 experimental frames varying from 159

to 357 with observations on a total of 2602 bees actually recorded, as shown in Figures 47. Three colonies were used for developing the brood, but owing to the strength of the colonies and the favorable weather conditions the variations in temperature were not as great as in the 1924 experiments, hence the limits of the complete developmental periods cannot be expected to be as great.

In preparing Figure 47, the minimum, average and maximum periods of development for each group of bees emerged are graphed separately. The minimum curves are partly theoretical in that the beginning point of each curve was arbitrarily set by subtracting 18 hours from the maximum for each particular group of the first emerged bees. Likewise, the beginning points of the average curves are partly theoretical since they are the average of the theoretical minimum and the true maximum. However in both the minimum and average curves the second points and all intervening to the last point are exactly true. The error induced by this arbitrary method is shown by the observation for one particular frame J of this group on which the first bee was starting to gnaw the capping at the first examination and at the last examination the last bee was just crawling out of its cell. In this case the method used gave an error of 12 hours for the minimum curve and six hours for the average, but owing to larger numbers of bees having emerged on the other frames at the first examination, the errors are not as great for these beginning points.

No records were kept of the time of capping of the brood but the smallest maximum period recorded for complete development was 20⅙ days for two bees on frame K. On the remaining frames numbers of workers varying from 5 to 247, a total of 660 or 25.3 per cent had emerged at the first examination or in a maximum period of 20 days 5¼ hours to 20 days 6⅔ hours. No doubt, many of these bees, such as those with the greater number emerged at the first examination (H, C, F.) actually required less than 20 days.

As shown by the maximum curve on Figure 47, of the 11 frames in the 1925 experiment, all had 81 per cent or more of the workers and all but two (E, D.) had between 90 and 100 per cent of their totals developed in less than 20 days 23 hours and 50 minutes as a maximum. The combined totals for all of the frames show that 1772 or 68.1 per cent of the 2602 emerged in less than 20 days 23 hours and 50 minutes, which added to the 25.3 per cent emerging in less than 20¼ days gives a combined total of 93.46 per cent emerging in less than 21 days. Since the second points are correct for the minimum and average curves of Figure 47, the conclusion can be drawn that 93.46 per cent of the bees

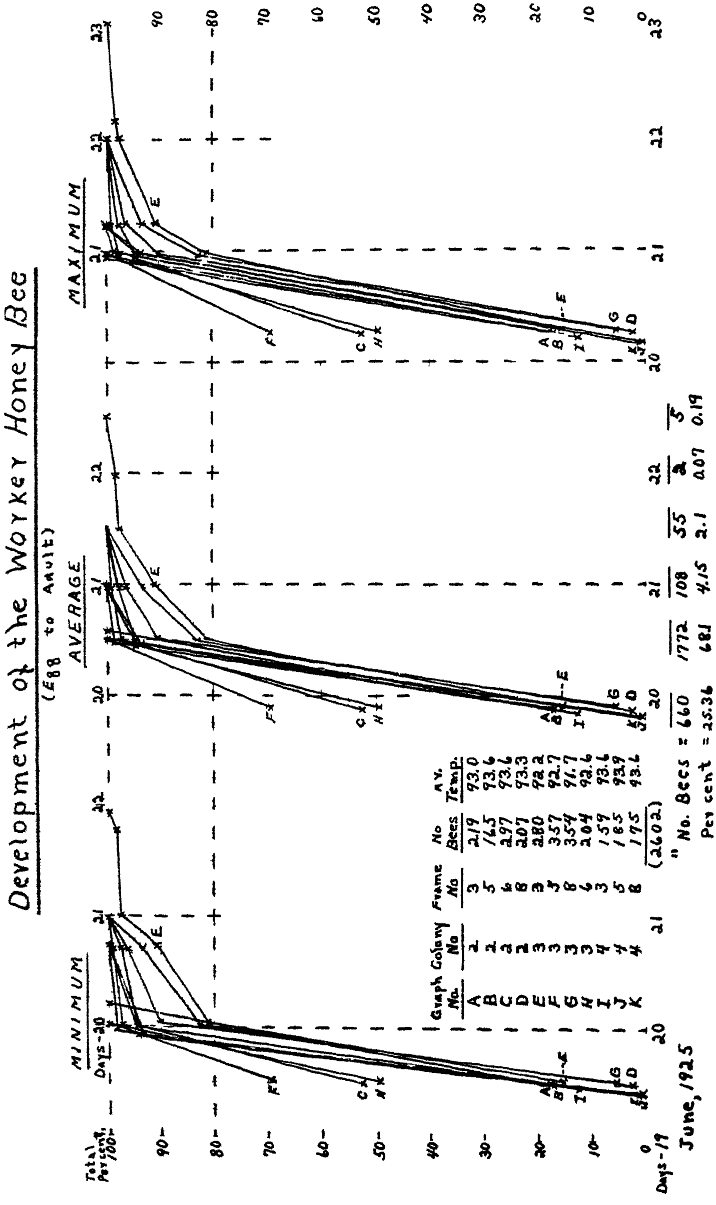

Development of the Worker Honey Bee
(Egg to Adult)
MINIMUM
AVERAGE
MAXIMUM
Total Per cent
June, 1925
No. Bees = 660
Per cent = 25.36
1772
68.1
108
4.15
55
2.1

FIG.—47.

under experiment had completed their development in an average time of 20½ days.

As in the 1924 experiments, one frame in particular showed considerable lengthening of the developmental period. While at least 43 bees or 15.3 per cent of the bees on frame E emerged in less than 20 days 6⅔ hours, one unemerged bee was active beneath its capping after a minimum period of 22¾ days.

Combining the results of the experiments for the two years, the following deductions can be stated. Upon observations of the developmental period of the workers of the honey bee the time of capping of the brood cells varied from less than eight days to more than 11 days, although the larger numbers were capped between the 8th and 9th days from the laying of the egg. Some actually emerged in less than 19⅞ days while others required more than 24 days for complete development from egg to adult. In one set of experiments, 74.6 per cent emerged in a maximum time less than 21¼ days, while in a more definitely controlled experiment, 93.46 per cent emerged in less than 21 days or an average developmental period for this portion of 20½ days.

THE RATE OF GROWTH OF WORKER, DRONE AND QUEEN LARVAE OF THE HONEYBEE, *APIS MELLIFERA* LINN.[1]

By HENRY A. STABE, *Assistant Professor of Entomology, Louisiana State University, Baton Rouge, Louisiana*

ABSTRACT

The growth rate of honeybee larvae was determined by weighing larvae individually or in groups at definite age intervals from hatching till maximum size was reached.

The growth rate of the honeybee larvae was determined by weighing larvae of different ages from those just hatched to the mature larvae. A discussion of methods used to obtain larvae of known age of the three different kinds follows.

WORKER LARVAE. A two-story observation hive with queen excluding zinc between the upper and lower story was made up and strengthened by the addition of bees until both combs were occupied. The upper story, in addition to having the glass sides, was provided with screen wire, 12 meshes to the inch, on the inside of the glass. It was found that, if the operator were careful not to breathe on the bees, the bees would continue to work without interruption when the glass

[1]The work being reported in this paper was done at Iowa State College, Ames, Iowa during the summer of 1929.

was removed. Small sticks of wood were cut of such size that they could be inserted tightly into the meshes of the screen with their inner ends entering the cells of the comb, for about one-half inch. As the queen left a cell after laying, one of these sticks was inserted into the opening of the cell thru the screen. The screen served to hold the stick which was used only as a temporary mark. When the queen finished laying a series of eggs and rested, each of these cells was marked by means of a quick drying lacquer applied with a stick to the sides of the cell. It was found that the lacquer remained on the wall of the cell for several weeks and did not interfere in any way with the work of the bees after it had dried.

The queen was observed for two hours and the cells in which she laid were marked in the same manner and constituted one lot. Since the incubation period of the honeybee egg is known to be approximately 76 hours, the age of the larvae could be very easily determined. A total of 25 lots of eggs was secured in this way. The times of weighing the larvae of the different lots were so arranged that lots of larvae at age intervals of six hours from zero to 144 hours were obtained. All of the larvae in a given lot were weighed at one sitting in order to eliminate as nearly as possible the effect of change of environment due to removing the comb from the hive. The larvae were reared in the brood chamber of a strong colony. Most of the older larvae were weighed singly and the results have been statistically treated.

Queen Larvae. The queen and the observation hive used in securing the worker larvae were also used to obtain the queen larvae. The queen was allowed to lay in the frame in the upper story of the observation hive for a period of about 21 hours. The frame was then removed and placed over an excluder in a strong colony and another frame was placed in the observation hive. This was done each day.

Three days after placing a given frame over the excluder most of the eggs had hatched and the young larvae in the cells varied in age from zero to 18 hours. The smallest of these larvae were selected and grafted into queen cell cups, a total of 64 cells on four bars being grafted each day.

Four strong colonies had previously been prepared for queen rearing and each received one of these bars. This was repeated each day until each queen rearing colony had six bars of queen cells. Five and one-half days after the first cells were grafted, the cells from two of the colonies were removed and the larvae were weighed individually. Twelve hours after this the cells from the other two colonies were weighed. This

resulted in obtaining lots of queen larvae at age intervals of 12 hours from 12 to 144 hours. This was repeated until five such series of larvae had been obtained.

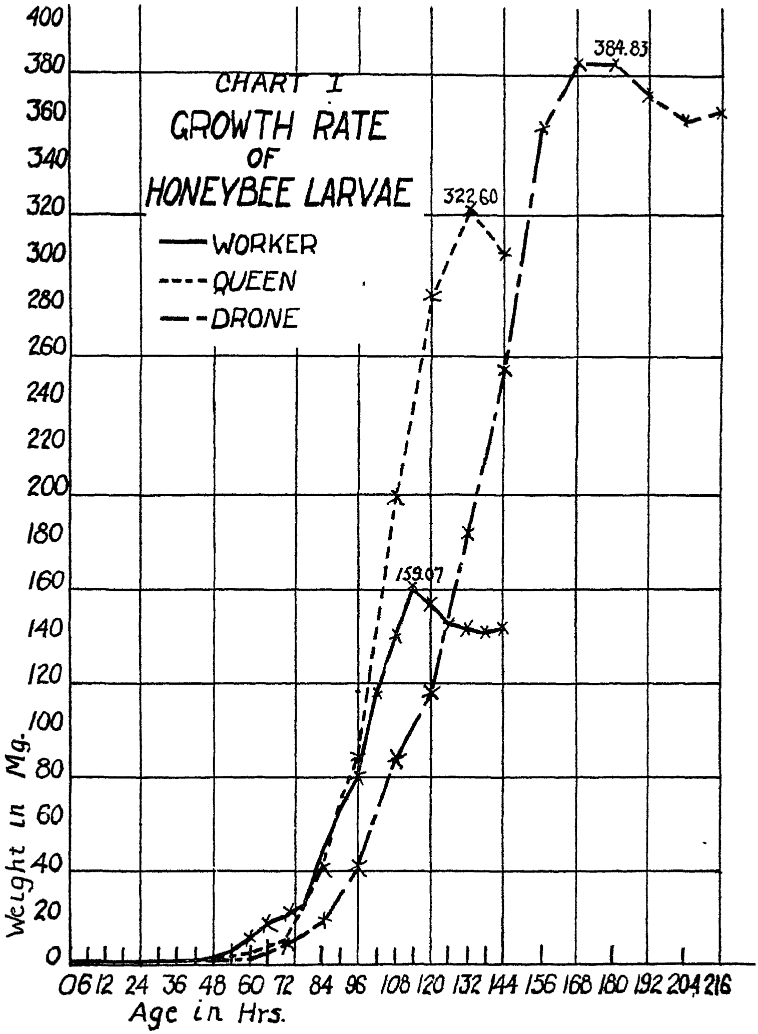


FIG.—48

DRONE LARVAE. A frame containing drone foundation was inserted into the brood chamber of a strong colony. In a short time the bees had drawn out the foundation and the queen had laid some eggs. The frame was removed and the eggs were destroyed. The frame was then

replaced and 12 hours later was again removed. The cells containing eggs were marked by means of lacquer. Usually only 100 cells were marked and the eggs in the unmarked cells were destroyed. This was

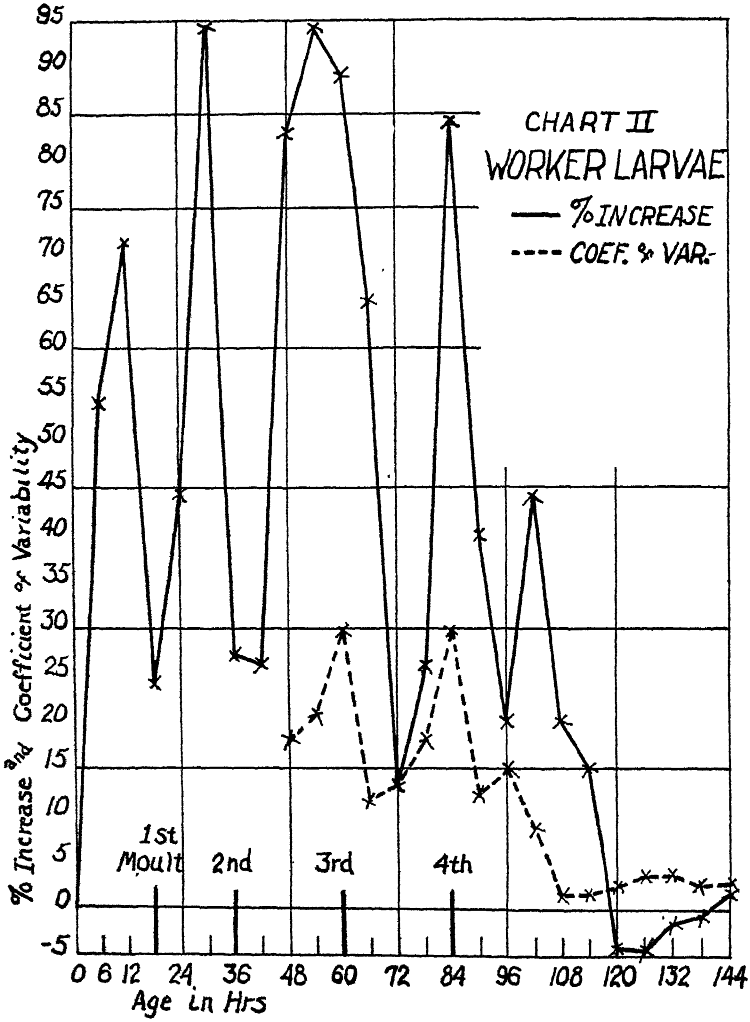


FIG.—49.

continued with this frame and others until 19 lots of eggs were obtained. The larvae were weighed at such times that lots of larvae at age intervals of 12 hours from zero to 216 hours were obtained.

RESULTS. Results are recorded in Tables 1, 2 and 3 and are shown graphically in Figures 48 and 49. These show that the increase in weight of honeybee larvae is relatively slow during the first few days. Later the increase becomes very rapid. When these weights are plotted against the time an S-shaped results as is shown in Figure 48. The maximum average weight of 159.07 mg. for worker larvae is attained in the 114 hour age group. For queen larvae the maximum average is 322.60 mg. and it is attained in the 132 hour age group. The maximum average weight for drone larvae is 384.+mg. and is attained in the 168 and 180 hour age groups.

COMPARISON OF GROWTH RATE OF QUEEN AND WORKER LARVAE. From Tables 1 and 2 and Figure 48, it is seen that for the first 48 hours the growth rate of queen and worker larvae is nearly identical. Following this the growth rate of the worker larvae is much faster than that of the queen larvae so that at 60 hours the worker larvae are more than twice as heavy as the queen larvae. At 72 hours the worker larvae still are heavier than the queen larvae. At 84 hours the average weights of the two kinds of larvae are nearly the same and following this the queen larvae increase in weight much more rapidly than do the worker larvae.

In Figure 49 the percentage increase over previous weight and the coefficient of variability are plotted against the age. The times at which the first four larval moults occur are also indicated in the figure.

As shown in the chart the growth rate, as indicated by the percentage increase, varies greatly from one six hour period to another. Other workers have shown that, in other insects, the growth rate is retarded just before, during, and after a moult. Referring to the chart, it is seen that, for the first two moults, this holds true for the honeybee. With the third and fourth moults the retardation seems to occur later. One would expect this as the percentage increase in reality measures the growth rate during the preceding six hour periods.

CONCLUSIONS

1. The maximum weight of worker larvae is attained between 114 and 122 hours.
2. The maximum weight of queen larvae is attained between 122 and 134 hours.
3. The maximum weight of drone larvae is attained between 164 and 184 hours.

4. The growth rate of worker larvae varies greatly during a given instar, being greatly reduced just previous, during, and after a moult.

5. The growth rate of worker and queen larvae is nearly identical for the first 48 hours.

TABLE 1. WORKER LARVAE

Date	Age in Hours	No. of Larvae	Total Weight mg.	Ave. Weight mg.	Increase Over Previous Weight	% Inc. Over Previous Weight	Coefficient of Variability
July							
16	0	70	7.7	0.11			
"	6	50	8.7	0.17	0.06	54	
"	12	50	14.3	0.29	0.12	71	
"	18	60	21.6	0.36	0.07	24	
"	24	50	26.0	0.52	0.16	44	
"	30	45	45.5	1.01	0.49	94	
"	36	50	64.4	1.29	0.28	27	
"	42	55	89.9	1.63	0.34	26	
"	48	16	48.5	3.03±0.09	1.40	83	17.80±2.17%
"	54	20	117.5	5.87±0.19	2.84	94	20.70±2.30%
"	60	23	255.8	11.12±0.48	5.25	89	29.94±3.25%
"	66	20	366.0	18.30±0.33	7.18	65	11.58±1.24%
"	72	22	452.3	20.56±0.40	2.26	13	13.18±1.37%
July							
15	78	34	881.3	25.92±0.55	5.36	26	18.02±1.51%
"	84	27	1344.3	47.79±1.88	21.87	84	29.82±2.99%
"	90	20	1335.1	66.76±1.25	18.97	40	12.12±1.30%
"	96	17	1363.2	80.19±1.98	13.43	20	14.64±1.76%
"	102	15	1734.2	115.62±1.79	35.43	44	8.58±0.92%
"	108	8	1111.2	138.90±0.79	23.28	20	1.50±0.25%
"	114	31	4930.7	159.07±0.36	20.16	15	1.84±0.16%
"	120	33	5028.7	152.38±0.62	6.48[1]	4.2[1]	2.32±0.19%
"	126	31	4512.7	145.57±0.62	6.81[1]	4.5[1]	3.48±0.30%
"	132	29	4147.9	143.03±0.65	2.54[1]	1.7[1]	3.55±0.31%
"	138	26	3687.6	141.83±0.50	1.20[1]	0.84[1]	2.60±0.24%
"	144	28	4030.3	143.94±0.51	2.11	1.5	2.71±0.24%

[1]Denotes loss.

TABLE 2. QUEEN LARVAE

Age in Hours	No. of Larvae	Total Weight mg.	Average Weight mg.	Coefficient of Variability
0	70	7.7	0.11	
12	45	12.9	0.29	
24	47	27.8	0.59±0.026	44.07±3.61%
36	45	57.7	1.28±0.028	21.09±1.62%
48	56	173.7	3.10±0.094	33.55±2.38%
60	28	131.3	4.69±0.16	27.08±2.65%
72	33	382.7	11.60±0.55	39.48±3.77%
84	36	1523.2	42.31±1.79	37.13±3.33%
96	37	3220.7	87.05±2.01	20.57±1.68%
108	31	6156.4	198.59±5.02	20.52±1.83%
120	31	8850.3	285.50±5.81	16.51±1.40%
132	38	12,258.9	322.60±2.52	7.03±0.81%
144	42	12,721.4	302.89±1.68	5.26±0.39%

TABLE 3. DRONE LARVAE

Date	Age in Hours	No. of Larvae	Total Weight mg.	Average Weight mg.
1929				
Aug. 5	0	70	7.7	0.11
5	12	100	25.0	0.25
5	24	60	23.3	0.39
5	36	80	86.2	1.08
5	48	85	171.0	2.01
5	60	75	247.8	3.30
Aug. 1	72	65	551.0	8.45
1	84	60	1148.2	19.13
1	96	63	2578.6	40.93
Aug. 16	108	154	13402.3	87.03
Aug. 1	120	8	922.4	115.30
1	132	63	11596.7	184.07
1	144	56	14207.7	253.71
1	156	46	16413.6	356.82
1	168	65	25010.8	384.78
Aug. 16	180	120	46179.4	384.83
16	192	115	42517.7	369.72
16	204	100	36016.1	360.16
16	216	105	38259.0	364.37

MR. HERMS: This paper interests me a great deal. Some years ago I worked on the growth of fly larvae. The results of the work of this gentleman correspond very closely with the results of flesh fly larvae. Could not measurements be taken at more frequent intervals than six hours? Your percentage curve might be changed somewhat, although the general appearance conforms very nicely with the work which I did, but I would like to see you do it at intervals of two hours.

PRELIMINARY REPORT CONCERNING FACTORS RELATED TO CERTAIN OF THE GROWTH PHASES OF *Bacillus Larvae*

By ARNOLD P. STURTEVANT, *Laramie, Wyoming*

ABSTRACT

Little work has been done on the growth phases of *Bacillus larvae*, the cause of American foulbrood. In the past, forty-eight hours incubation of cultures has been considered sufficient to demonstrate absence or presence of vegetative growth on artificial culture media. The present investigation has demonstrated that within certain lower limits, as yet not definitely determined, the smaller the seeding of spores of *Bacillus larvae* on a given culture medium, the longer is the incubation period necessary to obtain germination and vegetative growth. This may account for discrepancies between reports of cultures made of scales from combs subjected to sterilization processes, and apiary results.

There has been little work done on the growth phases of *Bacillus larvae*, the cause of American foulbrood, although this subject has been of considerable interest to bacteriologists in the study of numerous other organisms. Because of the fact that *B. larvae* grows with diffi-

culty, if at all, on ordinary culture media, but requires the addition of special growth producing substances to the medium, such as sterile egg yolk (11) or such vegetable extracts as carrot extract (7) in order to obtain growth, there have been difficulties in the way of making a complete cultural study of the growth phases of this organism.

It has been stated (9) (7) that germination of spores and growth of *B. larvae* will take place on a suitable medium with 24 hours incubation at 37°C., but maximum growth is not obtained much before 48 hours. Because of this fact there has been a tendency in most of the bacteriological work with *B. larvae*, to accept a 48 hour period of incubation as standard and sufficient in the various procedures for the isolation and cultivation of this organism on artificial culture media. This practice has been used particularly in the case of the bacteriological examination of American foulbrood scales from infected combs that have been subjected to various sterilizing processes, although Jones (6) in early work along this line states that in reporting on the culturing of scales treated by various disinfectants, all cultures were examined daily up to 14 days before negative results were recorded. In general, however, it has been assumed as previously stated by the writer (10) that "when no germination of spores was observed, as a rule only one examination of the culture was made at the end of 48 hours incubation, since if there are any spores in a condition to germinate they will do so within that period."

Two other facts have been noted in connection with the isolation of many cultures of *B. larvae*, that can only be explained in the light of a study of certain of the growth phases of the organism. It has been found that the use of a heavy initial seeding of spore containing material on the surface of the proper solid culture medium is more successful in producing initial good growth than when relatively small amounts of spores are used, (9). It often has been found impossible to obtain any growth at all when only a small amount of spore containing material is inoculated onto the medium and with 48 hours incubation. Furthermore, occasionally scales are found in unsterilized combs that will produce no growth after 48 hours incubation even though presumably uniform cultural methods are used in all cases.

For several years field studies have been in progress in an attempt to determine the minimum amount of infectious material, i.e., the actual number of spores of *B. larvae*, necessary to produce American foulbrood in healthy colonies of bees. This has been done by feeding to series of experimental colonies varying numbers of spores of *B. larvae* suspended in uniform quantities of sugar syrup. The numbers of spores

fed ranged from a heavy inoculation that would cause disease in every case, down to the controls fed no spores at all. In order to obtain further information on the ability of small numbers of spores to germinate and grow in comparison with the field studies, a large series of cultures were made in the laboratory during the spring of 1929, using as the inoculating material a standardized suspension of spores of *B. larvae* diluted in the same proportions and containing the same numbers of spores as in the field experiments, including also numerous intermediate dilutions. Certain facts have become evident from this work that throw new light on some of the questions mentioned above, making it seem advisable to change certain laboratory procedures in the bacteriological work on American foulbrood. However, since this investigation has not yet been completed, only a brief description of the experimental work will be given, sufficient to bring out the facts that seem to be of importance.

PROCEDURE. A suspension of spores of *B. larvae* was obtained by placing approximately 75 untreated American foulbrood scales in a flask containing 50 cc sterile water and glass beads. After becoming softened the scales were macerated by shaking the suspension with the glass beads for one-half hour. The suspension was then filtered through two thin layers of sterile absorbent cotton into a second sterile flask in order to remove any remaining masses of scale material. The number of spores per cubic centimeter of this material was determined by means of a Helber bacteria counting cell as well as by a direct method of counting similar to that devised by Breed and Brew (1) for counting the bacteria in milk by means of the microscope. After the suspension of spores was standardized to contain approximately 5,000,000,000 spores per cubic centimeter, a series of dilutions was made from the standardized suspension in sterile distilled water, each succeeding dilution having a gradually smaller number of spores per cc than the preceding. Then 1 cc of each dilution was transferred by means of sterile pipettes into each of a duplicate series of tubes of a special solid agar culture media. The medium used was the yeast-carrot agar media of Lochhead (7) to each tube of which 20 drops, or approximately 2 cc, of sterile egg yolk was added before the agar was solidified in a slanting position. These cultures were incubated at 37°C., for periods of time varying from 48 hours up to ten days. When long periods of incubation are used, care should be taken that the culture media in the tubes does not dry out. This can be prevented by the addition to the culture tubes from time to time of a few cubic centimeters of a sterile broth of similar composition to the solid base medium described above, without the addition of the sterile egg yolk.

OBSERVATIONS. Starting with a seeding of 5,000,000,000 spores per cc inoculated on the slanted solid culture media, it was found that at the end of 48 hours, growth had occurred in the first culture tube containing 1 cc of undiluted spores from the stock suspension and in the first dilution culture tube containing 500,000,000 spores but not in the second dilution culture tube containing 50,000,000. Another series of dilutions was made then with intermediate dilutions, making the step in the numbers of spores between each dilution inoculated even smaller. After incubating this series 48 hours at 37°C., slight growth was obtained in the dilution culture tube containing 60,000,000. Then a similar series of cultures was inadvertently incubated for six days before being examined. In this series it was found that slight growth was obtained in the culture tube inoculated with 5,000,000 spores. Now another series of similar dilutions was run incubating for 10 days at 37°C. in which series slight growth was obtained in the tube inoculated with only 700,000 spores.

Therefore, although this investigation is yet incomplete and the figures given may vary somewhat with different strains of the organism and with variations in different batches of culture media, it was found that while the smallest number of spores in a seeding producing growth after 48 hours incubation was twelve one-thousandths of the number of spores in the original suspension of 5,000,000,000 spores, after ten days incubation, the spores in a seeding containing only fourteen one hundred-thousandths the number of spores in the original suspension, or approximately a number 100 times smaller than the minimum seeding giving growth after 24 hours incubation, would germinate and produce growth. In other words, it is evident that within certain limits the smaller the seeding of spores, the longer must be the incubation period in order to obtain growth.

Another angle of this same problem was observed during the same spring of 1929 in connection with experiments to determine how small a number of viable spores would produce growth in cultures from American foulbrood scales that had been removed from combs subjected to varying lengths of exposure to the action of formaldehyde gas. In several cases, cultures from scales that apparently were near the borderline between partial and complete sterilization showed no growth or only a very few rods germinating from spores but producing no visible vegetative growth when examined after 48 hours incubation. When as much of the scale mass as possible was removed from the original culture media inoculated onto fresh media, and incubated for another 48 to 72 hours, in several instances good growth was obtained. This

practically amounted to increasing the length of the incubation period. Unfortunately it was not possible to carry this line of observation further under more carefully checked conditions, although it is given here as an indication of the same phenomena discovered above.

Discussion. Bacteria are known to pass through quite a definite cycle of growth, particularly when cells from an old culture are transferred to fresh culture medium. Only the initial stages of this cycle are of interest in relation to the work herein reported on *B. larvae*, no studies having been made so far as to the later phases of the growth curve. These stages have been described by various investigators (2) (5) somewhat as follows; the initial stationary phase during which no growth takes place, the logarithmic phase when the organisms begin to divide slowly at first, gradually accelerating, and so on through the complete cycle of growth. These initial phases as described by Buchanan (3) are more clearly marked with spores than with simple vegetative organisms since there is a period of varying length of time necessary for the spores to germinate and start vegetative growth after implantation in a suitable medium. It also has been observed that this initial period of apparent dormancy varies considerably with different organisms, the spores of some spore forming organisms remaining dormant in some cases for many days before starting growth (4).

Furthermore it has been observed by Henrici (5) that "various factors as temperature; the size, age and previous history of the inoculum; and the composition and nutrient value of the medium, influence the form of the growth curves of bacteria and "of the various factors which influence the rate of growth and form of the growth curve, the initial number of cells introduced into a unit volume of medium seems to be one of the most important." It has also been shown by Robertson (8) in studies of subcultures of certain protozoa, that growth apparently seems to be stimulated by the presence of other cells of the same type. Various theories have been proposed as to the nature of this stimulus (3) (5) but they will not be discussed at this time as more work is necessary along this line with *B. larvae*. It is known, however, that there are certain organisms, such as the pneumococcus, with which it is very difficult to obtain single-cell isolations.

In the light of such observations it is now easier to understand the results obtained with cultures of *B. larvae*. In the work herein reported the temperature of incubation was constant, 37°C., although the period of incubation was varied. The age and previous history of the spores was practically the same in all cases since the organisms were all obtained from dried down American foulbrood scales containing nothing

but spores. Therefore, it is evident that as the size of the seeding was decreased a point was reached where the numbers for some reason were too small to start growth within the 48 hours incubation period. However, by increasing the length of the incubation period, the minimum seeding that would produce growth was materially decreased. There seemed to be a point somewhat variable beyond which the seeding could not be reduced and obtain growth. Apparently the growth stimulus, whatever it is, had been reduced below the necessary minimum. Also with the smaller seedings the period of dormancy seemed to be lengthened, because where growth did occur, it did not become apparent until towards the end of the lengthened incubation period while with the larger seedings good growth occurred within 48 hours.

CONCLUSIONS. While these observations are only of a preliminary nature and much more work is necessary upon the entire subject, certain facts seem sufficiently evident from which to draw a few conclusions.

1. In order to obtain definite growth of *Bacillus larvae* in a minimum of time, a heavy seeding of viable spores on a suitable culture medium is necessary.

2. Within certain limits not yet definitely determined, the smaller the seeding of spores of *Bacillus larvae*, the longer is incubation period necessary to obtain vegetative growth.

3. Therefore, in culturing American foulbrood scales that have been subjected to various methods of sterilization in order to determine the efficiency of the sterilizing process, the period of incubation of the cultures should be increased to at least ten days if not more before negative growth results are reported.

LITERATURE CITED

1. BREED, R. S., and BREW, J. D. 1916. Counting bacteria by means of the microscope. N. Y. State Agricultural Experiment Station, Technical Bulletin, No. 49, 31 p.
2. BUCHANAN, R. E. 1918. Life phases in a bacterial culture. Journal of Infectious Diseases, 23:109–125.
3. ——— 1928. Growth curves of bacteria. Chapter V, pp. 46–57 from The Newer Knowledge of Bacteriology and Immunology, by Jordan and Falk. 1196 p. Chicago.
4. BURKE, V., SPRAGUE, A., and BARNES, LAV. 1925. Dormancy in bacteria. Journal of Infectious Diseases, 36:555–560.
5. HENRICI, A. T. 1928. Morphologic variations and the rate of growth of bacteria. 194 p. Baltimore.
6. JONES, D. H. 1924. Control of American foulbrood. Summary of some laboratory tests with disinfectants in this disease. Gleanings in Bee Culture, 52; 364–365.

7. LOCHHEAD, A. G. 1928. Cultural studies of Bacillus larvae (White). Scientific Agriculture, 9:80–89.
8. ROBERTSON, T. B. 1923. The Chemical basis of growth and senescence. 389 p. Philadelphia.
9. STURTEVANT, A. P. 1924. The development of American foulbrood in relation to the metabolism of its causative organism. Journal of Agricultural Research, 38:129–168.
10. ——— 1926. The sterilization of American foulbrood combs. U. S. Department of Agriculture, Circular 284, 28 p.
11. WHITE, G. F. 1920. American foulbrood. U. S. Department of Agriculture, Bulletin 809, 46 p.

THE AMERICAN HONEY INSTITUTE

By KENNETH HAWKINS

Since its inception in March, 1928, the American Honey Institute has taken so active an interest in scientific research in beekeeping and particularly the use of honey as a food that the Institute deserves the consideration and support of every member of the A.A.A.S.

More recently, Dr. H. E. Barnard, director of the Institute, has been chosen by President Hoover to take a very active part in the child welfare work being fostered by the government. Dr. Barnard was formerly director of the American Institute of Baking and has active contacts with the research being done along these avenues. His present connections with several large food corporations in a scientific way give him additional contacts.

The Institute is fostering research on the use of honey as a food so that physicians may be supplied with reliable information regarding the food value of honey. Bakers are being supplied with recipes, enabling them to scientifically use honey in their products. Many large food packers are for the first time offering their products to consumers through recipes in which honey is playing a part, as a result of this scientific research fostered by the Institute.

The privilege of presenting this information so briefly is to more fully to acquaint you with the scientific work of the American Honey Institute in the hope you may feel justified in urging associations of honey producers in your territory to support the Institute, morally and financially. Mr. L. C. Dadant of Hamilton, Illinois, is the treasurer and Mr. L. W. Parks of Watertown, Wisconsin, is president. Let us help you in your bee and honey problems in any way we can.

PYRETHRUM AND SOAP, A CHEMICALLY INCOMPATIBLE MIXTURE

By R. C. Roark, *Insecticide Division, Bureau of Chemistry and Soils, Washington, D. C.*

Much work done by entomologists and reported in the literature shows an apparent ignorance of the nature of the insecticidal constituents of Pyrethrum (*Chrysanthemum cinerariaefolium* Trev.). The compounds responsible for the toxic action are now known, and their chemical nature should be kept in mind in planning entomological tests.

The designation "oleoresin of Pyrethrum" is an old pharmaceutical term applied to the ether extract of Pyrethrum flowers. This extract contains a small quantity of volatile oil and a number of other constituents, of which two, known as Pyrethrin I and Pyrethrin II, contribute the characteristic insecticidal action of the flowers. The structure of these two compounds was first established by Staudinger and Ruzicka in work done from 1910 to 1916 but not reported until 1924, (Helvetica Chim. Acta., v. 7, pp. 177–259, 377–458, 1924) and the conclusions have been confirmed by LaForge (U. S. D. A. Bul. 824 rev., April, 1926, pp. 72–75); and Yamamoto (Chemical Abstracts, v. 20, p. 41, 1926). The pyrethrins both belong to a class of organic compounds known to chemists as esters. Esters are compounds formed by the combination of an acid with an alcohol. For example, the ester known as ethyl acetate may be formed by combining ethyl alcohol and acetic acid

$$\underset{\text{Ethyl alcohol}}{C_2H_5OH} + \underset{\text{Acetic acid}}{CH_3COOH} \rightleftharpoons \underset{\text{Ethyl acetate}}{CH_3COOC_2H_5} + \underset{\text{Water}}{H_2O}$$

The reaction is reversible, which means that in contact with water an ester is decomposed partially into its component parts—alcohol and acid. Heating greatly accelerates the speed of this reaction, the general rule being that the rate doubles for each increase of 10 degrees centigrade. Thus Pyrethrins I and II are probably decomposed by water 4 times as fast at 40°C. (104°F.) as at 20°C. (68°F.). Further, in the presence of an aqueous solution of alkali an ester decomposes more completely and more rapidly than in the presence of water alone, owing to the fact that the reaction is then irreversible, the liberated acid being bound by the alkali as fast as it is formed.

$$\underset{\text{Ethyl acetate}}{CH_3COOC_2H_5} + \underset{\text{Sodium hydroxide}}{NaOH} = \underset{\text{Sodium acetate}}{CH_3COONa} + \underset{\text{Ethyl alcohol}}{C_2H_5OH}$$

In entomological literature there are reported many tests made with pyrethrum powder in combination with soap, or with an alcoholic or other extract of pyrethrum combined with soap. Ordinary soap is a mixture of the sodium salts of higher fatty acids, especially oleic, palmitic and stearic acids. These soaps in dilute solution partially hydrolyze forming a dilute solution of sodium hydroxide, which in turn saponifies (decomposes) the Pyrethrins I and II. Many soaps made primarily for use as insecticides contain even an excess of alkali, in which case the Pyrethrins would be more rapidly decomposed. Pyrethrum extracts containing soap are on the market. These extracts are not anhydrous, but contain from 25 to 50 per cent water, under which conditions the Pyrethrins decompose slowly.

In apparent contradiction to the facts stated above many favorable results have been reported on the use of Pyrethrum flowers or a Pyrethrum extract in combination with soap. Probably these results have been obtained because the mixture was sprayed on the insects before the Pyrethrins had completely decomposed.

It must also be remembered that soap alone is a powerful insecticide against aphids, Japanese beetle (van der Meulen and Van Leeuwen, J. Econ. Ent., v. 22, p. 812, October, 1929) and many other insects. When soap and Pyrethrum extract are added to water the Pyrethrins (esters) begin to decompose. The decomposition is hastened by heat. The higher the concentration of alkali the greater and the more rapid is the decomposition; the longer the time of contact, the greater the decomposition.

Very careful insecticidal tests have been made by Staudinger and Ruzicka (ibid., pp. 453–8) and C. H. Richardson (U. S. D. A. Bul. 824 rev. April 1926, footnote p. 73) with the acids and alcohols which make up Pyrethrins I and II, but in all cases the insecticidal action of these was markedly less than that of the Pyrethrins. In other words when the Pyrethrins are saponified the resulting products are practically valueless as insecticides. The Pyrethrins are high priced insecticides. Pyrethrum flowers are now (March 1930) quoted at 35 cents per pound wholesale. Very few flowers contain more than 1 per cent of the two Pyrethrins, and the average is much less. Assuming a 1 per cent content of Pyrethrins in the flowers, the present cost of these constituents (unextracted) is about $35 per pound. It may be calculated that 1 gram sodium hydroxide will completely saponify 8.25 grams Pyrethrin I or 4.675 grams Pyrethrin II. Assuming Pyrethrin I and Pyrethrin II to be present in the flowers in a 50:50 ratio, three cents worth of lye (1 pound NaOH) will wholly destroy the insecticidal constituents of

$226.10 worth (646 pounds at 35 cents per pound) of Pyrethrum flowers. Such high priced insecticidal material should be handled with a knowledge of its chemical and physical properties. If soap *must* be used in combination with Pyrethrum or a Pyrethrum extract, the soap should be as nearly neutral as possible, no excess soap should be added, the solution should not be heated, and the solution should not be allowed to stand before being sprayed upon the insects. Failure to observe these rules will result in highly variable kills, owing to the variable decomposition of the Pyrethrins.

Pyrethrum is incompatible not only with soap but also with hydrated lime, lime-sulphur solution, sodium-sulphur and barium-sulphur combinations, dry lime-sulphur and other materials which dissolve in or are hydrolyzed by water to form alkaline solutions. Pyrethrum, or extracts thereof, should be sprayed in a solution, emulsion or suspension as nearly neutral as possible, and as soon as possible after being mixed with water.

The author believes that the addition of saponin, of sulfonated oxidation products of petroleum so successfully used with nicotine (Ind. Eng. Chem. v. 21, p. 542, June 1929), or other wetting or activating agents to Pyrethrum or a Pyrethrum extract (free from soap) will in most cases produce a mixture of at least as high toxicity as a mixture containing soap, and will have the advantage of being less readily decomposed.

In buying Pyrethrum flowers or extracts thereof it would be well if the purchaser would insist on a statement from the manufacturer giving the exact percentage of Pyrethrins present. Methods for the quantitative determination of Pyrethrins I and II have been proposed (Staudinger and Harder, Ann. Acad. Sci. Fennicae, *29A*, pp. 1–14, 1927; Tattersfield, Hobson and Gimingham, J. Agr. Sci., *19*, pt. 2, April 1929; Gnadinger and Corl, J. Am. Chem. Soc., *51*, pp. 3054–3064, 1929). While none of those methods have as yet been adopted by the Department of Agriculture, they represent a great advance upon previous methods and can probably be improved. An accurate and practical chemical method for the evaluation of Pyrethrum will doubtless soon be forthcoming.

A SIMPLE AND EFFECTIVE ANT TRAP FOR HOUSEHOLD USE

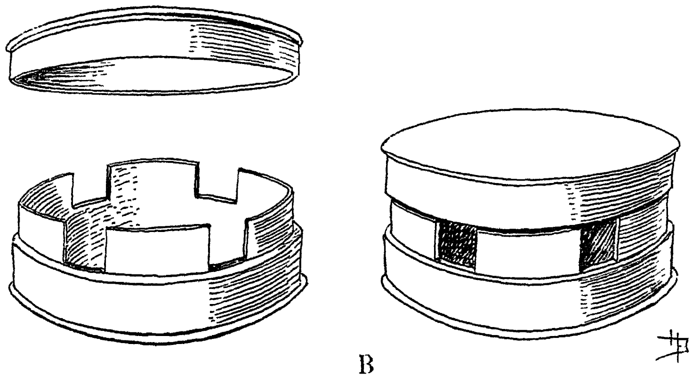
By R. T. COTTON and G. W. ELLINGTON, *U. S. Bureau of Entomology, Washington, D. C.*

ABSTRACT

Directions are given for making a simple yet effective ant trap for use in houses.

While suppressing an outbreak of the little red ant or Pharaoh's ant, *Monomorium pharaonis* L., in the kitchens of the White House, the writers designed and tested a container for a poisoned syrup that is so simple and convenient and gives such excellent results that it seems worth while describing.

The container for this ant poison consists of an ordinary pill box the interior of which has been washed with a solution of hot paraffin to make it water tight. As shown in Figure 50, A and B, four small sec-



A B

FIG. 50.—A simple ant trap made from an ordinary pill box. A, pill box with cap removed to show the notches cut in inside collar; B, pill box with cap in place, ready to use, showing openings for the ants to enter.

tions of cardboard are removed from the inner circular collar, over which the top or cap of the pill box fits. When the container is in use, the top of the pill box is partially raised, exposing four small openings where the cardboard has been cut away, and through these the ants can enter to obtain the syrup. The contents of the box are protected by the cap from dust and excessive evaporation, and pet animals are unlikely to be attracted to such a closed container.

The containers, being small, are relatively inconspicuous and can be placed around wherever the ants are troublesome. When not in use it is a simple matter to press down the covers and set the boxes aside until needed.

The boxes should be about two-thirds filled with small pieces of blotting paper, to which is added a small quantity of a poisoned syrup. The syrup may be renewed as often as necessary.

In testing these containers, the writers used the poisoned syrup made with thallium sulphate, described by Popenoe in *Science*, Volume LXIV, No. 1665, page 525 (1926). It consists of 1 pint of water, 1 pound of sugar, 27 grains of thallium sulphate, and 3 ounces of honey, the whole being thoroughly stirred and brought almost to a boil. Since thallium sulphate is a powerful and insidious poison, care should be taken not to breathe the vapors given off by the syrup as it is being prepared.

When used in the containers described above, the writers found this syrup to be exceedingly effective against the little red ant that is so common in dwellings. Infestations were wiped out within a few days.

Scientific Notes

The Predaceous Habit of *Cyrtopeltis varians* Dist. On August 16, 1929, while making observations on the corn earworm, *Heliothis obsoleta* Fabr., a field of Perique tobacco which had been cut in June and the stubble left for seed production was examined and several adults and nymphs of *Cyrtopeltis varians* were observed with their beaks inserted in the eggs of species of *Heliothis*. This hemipteron was fairly abundant in both the adult and nymphal stages and moved about more or less constantly, rather swiftly at times, through and over the tops of the plants. The manner of their movement indicated that they were searching for eggs and young larvae of *Heliothis*. The efficient work of the predator was further evidenced by the scarcity of *Heliothis* larvae upon the tobacco plants. Occasionally a larva of an advanced instar was found. From material collected and placed in the laboratory at Baton Rouge, Louisiana, several nymphs were reared to maturity on the eggs of *Heliothis*, and one specimen was reared on first-instar and second-instar larvae. The eggs of *Heliothis virescens* Fabr. were present in greater numbers than those of *Heliothis obsoleta.*

No indication that the hemipterons had fed on any part of the plant was observed, either in the field or in the laboratory.

O. W. Rosewall, *Louisiana State University*, and
C. E. Smith, *Bureau of Entomology*

Experiments with Codling Moth Bands Treated with Lead Arsenate. In experiments with newly-hatched codling moth larvae, during the year 1924–25, the fact was determined that larvae become poisoned while crawling on a surface sprayed or dusted with lead arsenate (See Hilgardia Vol. 1. 1925). The poisoning appears to be the result of the larvae swallowing particles of lead arsenate more or less accidentally. This led to the suggestion that mature larvae might be killed by treating bands with lead arsenate dust. Early in August, 1929, three different band treatments were started. The final examinations were made the first of October. Ten ounce burlap, folded to three thicknesses, was used. The results were as follows:

	Per cent of larvae dead
Untreated bands	10.6
Bands filled with lead arsenate	13.3
Bands filled with lead arsenate and underlying bark coated with lead arsenate	7.7

The poison apparently had no effect on the larvae. This fact is difficult to explain. Numerous instances were observed in which larvae were heavily coated with the poison, and in a few cases they were found literally embedded in masses of the dust, yet seemingly unaffected. The evidence suggests two possibilities. The larva swallows strictly nothing after it leaves the fruit or else it may swallow occasional particles, as does the newly-hatched larva, but the amount swallowed is insufficient to prove fatal.

RALPH H. SMITH, *University of California*

Grasshoppers vs. Salt. The following notes on food preferences of grasshoppers (Acrididae) were made some time ago while engaged in a study of their likes and dislikes with reference to their attacks on binder-twine. The species chiefly involved were *Melanoplus bivittatus* with some *M. differentialis*, and included several smaller species in less numbers. The locality was central Nebraska.

It was early learned that there was much difference in the degree of attack in various fields inhabited by essentially the same type and density of grasshopper population. During the last season in which experiments were conducted, which were carried on partly by exposing treated samples in infested fields and partly by exposing them in cages to captive insects, it was discovered that under certain circumstances even salt, which is often used in bait as an attractant, sometimes did not act as such. Treated samples, carrying salt alone, or salt plus other substances, were alike ignored and remained unattacked, even if cantaloupe juice, lemons, or "banana oil" were added. Why?

As nearly as could be judged, the reason lay in the fact that grasshoppers which had been feeding upon alfalfa or sweet clover felt no craving for salt. These leguminous plants apparently contained some principle which satisfied this craving, which remained unsatisfied in those that had fed only on the wild grasses and similar vegetation of their habitat. When the samples were presented, especially in the field, to these latter insects, they were quickly disposed of if salted, and sometimes if not. Perhaps the biological chemist can tell what substance is involved.

This brief note is published in the hope that it may perhaps explain some otherwise puzzling results obtained in experiments with grasshoppers.

Crickets, generally speaking, reacted to twines like grasshoppers in my experiments. However, crickets are apt to be most plentiful in those grain-fields where there is clover or other green lower stratum serving as a shelter, and when present are sometimes quite destructive to twine. Unlike grasshoppers, which usually devour the twine, particularly on the exterior of shooks, the crickets worked chiefly in the interior, typically making a clean cut, apparently out of sheer mischief;—as one farmer expressed it—"just to hear the bands pop!"

ALBERT P. MORSE, *Peabody Museum, Salem, Mass.*

The Lesser Corn Stalk borer (*Elasmopalpus lignosellus* Zell.) **Attacking Strawberry Plants.** A survey of the strawberry fields in the Chadbourn, North Carolina, and Plant City, Florida, districts during the fall of 1929 resulted in the finding of many plants, generally distributed over these districts, which showed evidence of some injury to the growing bud. This condition was similar to a disease known locally as "crimps," "dwarf," "French bud," or "blind plant." Closer observation, however, showed evidence, in most cases, of injury due to the feeding of the lesser corn stalk borer (*Elasmopalpus lignosellus* Zell.).

The presence of this borer in strawberry plants may have been overlooked during past years or the infestation the past season might have been the result of some unusual condition.

The method of growing strawberries in the Chadbourn district appears to be particularly favorable for the multiplication of the lesser corn stalk borer and infestation of the strawberry plants by it. The same may be true, to a limited extent, for the Plant City district. Most of the strawberry growers in the Chadbourn area grow a crop of tobacco which demands all of their attention at a time when the strawberry fields need cultivation. The result is that the strawberry fields are allowed to become overgrown with weeds and grasses until the tobacco crop is harvested. Among the weeds and grasses found in the strawberry fields are many favored host plants of the lesser corn stalk borer. When these host plants are finally cut and the strawberry fields cultivated the only available food for the larvae is the strawberry plants. In the Plant City district the general practice is to prepare the land from two to six weeks before setting to strawberries. Frequently, however, plants are set directly after the fields are prepared and thus are available for attack by any borers which might have been feeding in the recently removed weeds and grasses. Also the nursery beds, which are used as a source of plants, are sometimes allowed to grow up to weeds and thus serve as an attractive place for oviposition by the moths. The larvae then may be transferred to the fields with these plants.

It is often difficult to determine with certainty whether or not a plant is infested with the lesser corn stalk borer without pulling the plant to pieces to find the feeding galleries. The most conspicuous indication of the borer's presence is the dead and dried young leaf in the crown. This, together with the silklike tubes to which the soil particles cling, serves as the best evidence that the plant is infested.

No strawberry fields have been found in which the loss resulting from the infestation of this stalk borer was of any great economic importance. The center of the crown is often entirely killed, with the result that side shoots are produced which will probably never yield as much fruit as would have been the case with the original crown. Frequently only a portion of the crown is destroyed, in which case the remaining part of the plant appears to develop normally. One or two cases have been found where the plant was killed outright.

C. F. Stahl, *Bureau of Entomology*

Spray Coverage. Recently certain insecticide manufacturers have made claims regarding the covering qualities of their products, stating that certain brands of miscible oils were superior to lime sulfur and homemade lubricating oil emulsion.

The experiments here reported were intended to bring out, if possible, differences in coverage between certain types of oil sprays and lime sulfur. Two series of tests were conducted, including four different materials. The first series of tests were applied in the fall and the second in the spring, using the same orchard in each case.

TABLE 1. FALL APPLICATIONS,
COMMERCIAL ORCHARD, UNIVERSITY OF ILLINOIS, URBANA, ILLINOIS

Sequence	Material Used*	Dilution	Date, 1928	Upper Gun Tower Min.	Upper Gun Tower Sec.	Lower Gun Ground Min.	Lower Gun Ground Sec.	Total Both Guns Min.	Total Both Guns Sec.	No. Trees	Weather
			Dec.								
1	Commercial Oil No. 1	1–50	10	27	27	20	47	48	14	28	Quiet
2	Commercial Oil No. 2	1–15	10	24	32	19	42	44	14	29	Quiet
3	B. F. O. S.†	1.5–50	10	23	44	20	46	44	30	26	Quiet
4	Lime sulfur	1–9	10	22	42	22	45	45	27	23	Quiet
5	Lime sulfur	1–9	11	23	10	20	41	48	1	32	Quiet
6	B. F. O. S.†	1.5–50	11	20	20	21	56	42	16	25	Quiet
7	Commercial Oil No. 2	1–15	11	23	32	21	45	45	17	31	Quiet
8	Commercial Oil No. 1	1–50	11	21	44	21	50	43	34	31	Quiet, cloudy
FRESHMAN ORCHARD, UNIVERSITY OF ILLINOIS, URBANA, ILLINOIS											
9	Commercial Oil No. 1	1–50	11	27	18	17	16	44	34	156	Quiet, cloudy
10	Commercial Oil No. 2	1–15	11	27	39	24	25	52	4	156	Quiet, cloudy
11	B. F. O. S.†	1.5–50	12	28	22	16	42	45	2	154	Quiet, cloudy
12	Lime sulfur	1–9	12	27	54	15	13	43	7	137	Moderate wind—south. Cloudy

*200 gallons of material applied in each test. A stop watch was used to record the time each application required and each gun was in operation. "Bean" outfit used at 250–300 pounds pressure.

†Boiled Fish Oil Soap Emulsion (Illinois formula).

TOTALS ON LARGE TREES

Treatment	No. Trees	Time Required Minutes	Time Required Seconds
B. F. O. S.	51	86	46
Commercial Oil (No. 2)	60	89	31
Commercial Oil (No. 1)	59	91	48
Lime sulfur	55	93	28

TABLE 2. SPRING APPLICATIONS, COMMERCIAL ORCHARD, UNIVERSITY OF ILLINOIS, URBANA, ILLINOIS

Sequence	Material Used*	Dilution	Date, 1929	Upper gun Tower Min.	Upper gun Tower Sec.	Lower gun Ground Min.	Lower gun Ground Sec.	Total Both Guns Min.	Total Both Guns Sec.	No. Trees	Weather
			March								
1	Commercial Oil No. 1	1–50	18	25	48	21	17	47	15	28.5	Strong southwest wind.
2	Commercial Oil No. 2	1–15	18	25	0	23	13	48	13	30.5	Strong southwest wind.
3	Lime sulfur	1–9	19	26	54	21	20	48	14	23.0	Strong southwest wind.
4	B. F. O. S.†	1.5–50	19	24	42	21	20	46	2	27.0	Strong southwest wind. Shower.
5	B. F. O. S.†	1.5–50	20	27	12	23	33	50	45	27.0	Moderate southwest wind
6	Lime sulfur	1–9	20	20	30	27	54	48	24	31.0	Moderate southwest wind
7	Commercial Oil No. 2	1–15	20	24	30	25	25	49	55	24.0	Strong southwest wind.
8	Commercial Oil No. 1	1–50	20	20	51	26	37	47	29	31.0	Strong southwest wind.

*200 gallons of material applied in each test. A stop watch was used to record the time each test required and each gun was in operation. Hardie outfit used at 350 lbs. pressure.

†Boiled Fish Oil Soap Emulsion (Illinois formula).

Note: Sequence 1 and 2 applied on the same trees as in fall of 1928; all others on different trees.

TOTALS OF TIME REQUIRED FOR ABOVE TESTS

Treatment	No. Trees	Time Required Minutes	Time Required Seconds
Commercial Oil No. 1	59.5	94	44
Lime sulfur	54.0	96	38
B. F. O. S.	54.0	96	47
Commercial Oil No. 2	54.5	98	68

Experienced spray men made the applications but these men were instructed to spray in the usual way and had no knowledge of the tests being conducted. Two standard spray rigs of different makes were used. The results of these experiments failed to substantiate claims for the superior covering qualities of certain commercial sprays.

There seems to be a slight advantage in favor of miscible oils over lime sulfur and oil emulsion. The difference, however, is very small and it seems probable that this difference may be due to the fact that the workmen in applying the sprays can more clearly see the twigs hit with the miscible oil sprays and perhaps cease spraying slightly sooner than is the case where they were using the less visible materials. The actual time involved in making the applications does not vary greatly.

H. W. ANDERSON, W. P. FLINT, M. D. FARRAR, M. A. SMITH

A Factor Concerned in Arsenical Injury to Foliage. Special investigations of foliage injury by arsenicals were begun at the gipsy moth laboratory in 1927. Harvard University cooperated to the extent of furnishing laboratory facilities and C. R. Addinall, instructor in chemistry at that institution, was temporarily employed to assist in the studies. The following paragraphs indicate, in a brief way, the various aspects that have been given attention.

As all acids attack arsenates, one is reminded that organic acids (oxalic, citric, succinic, tartaric, tannic, etc.) and their salts are found in many plants. With this in mind the hydrogen-ion concentration of transpiration water, dew, fog, and rain water from the leaves of about 50 species of plants was investigated. A neutral to alkaline condition was indicated in the case of three species known to be very resistant to the arsenate and Bordeaux mixture, while all the other species gave an acid condition of varied pH.

Laboratory tests of the action of acidity, temperature, light, distilled water, tap water, and atmosphere on the arsenates are not sufficient, since under natural conditions the arsenates and lime on the leaf are continually moistened by transpiration, atmospheric moisture, dew, fog, and rain. Into this water is dissolved a continuous supply of well-buffered weak acid from the plant, a portion of accidental dust, and considerable carbon dioxide. Hence, the arsenates on the plant are continually put into solution by the impure water environment. An average monthly precipitation of 3.45 inches during the summer caused a relatively large volume of acidulated leaf wash to pass over a relatively small quantity of arsenate on the foliage. This precipitation was from a number of rains which occurred at intervals through a somewhat extended period of time.

To study the action of arsenates on a number of species of plants 39 plots were sprayed or dusted. Before and after various quantities of rain, determinations were made of the pH, the quantity of arsenate, the percentage of soluble arsenic, the quantity of arsenic in the tissue, the quantity of accidental dust, and the quantity of dew, per 100 square inches of leaf surface. These determinations were used in studying the effect of chemical and meteorological factors upon the degree of arsenical injury to various kinds of foliage.

The results suggested that calcium arsenate and lead arsenate were much more soluble on the acid leaf surface than in distilled water, and that calcium arsenate was, apparently, much more soluble than lead arsenate. When mixed with lead arsenate, lime apparently formed considerable calcium carbonate and calcium

arsenate (Campbell, F. L. On the role of calcium hydroxide in hydrated lime—acid lead arsenate sprays, Jour. Agr. Res., Vol. XXXII, No. 1, pp. 77–82). When heavily dosed with lime some foliage may at first give a slightly alkaline reaction with water, but the first rain of any consequence removes much of the lime, carrying with it considerable of the arsenate. The surface of the leaf then becomes acid and seemingly is able to form lead and calcium salts at the expense of the arsenate, thus setting free the arsenic acid, which would seem to be readily absorbed by the tissues, particularly in the case of young foliage which is not so thickly cutinized as mature foliage. Lime was very soluble in water on the leaf at ordinary summer rain temperature; the first 0.2 inch of rain washed off over 85 per cent of the deposit of poor grade lime and considerably less if the lime was of a high grade. It would appear, therefore, that much of the protection from arsenical injury is due to the removal of the arsenates from the foliage through the leaching effect of the lime, particularly if the latter is of a poor grade.

This brief article is not intended to be conclusive or final, for all experiments must be checked further and the chemical and physiological aspects of the problem studied in detail in relation to various meteorological conditions.

S. F. Potts, *Forest Insect Investigations, U. S. Bureau of Entomology*

INDEX IV OF AMERICAN ECONOMIC ENTOMOLOGY

The manuscript is being prepared for Index IV, which will cover the five year period from 1925 to 1929 inclusive. It is believed that it will be possible to have this publication printed and ready for distribution during the summer. The book will be about the same size as the previous index and will be of great value to all working entomologists. Further details will be sent to all members of the Association as soon as the approximate date of publication can be determined.

A. F. Burgess, *Secretary*

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

APRIL, 1930

The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication at $2.50 per page for all matter in excess of six printed pages, a part page counting as a full page, this limit not including acceptable illustrations. Photo-engravings may be obtained by authors at cost.

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ANNUAL SCIENTIFIC MEETINGS: 1930–31, Cleveland; 1931–32, probably New Orleans; 1932–33, Chicago; 1933–34, undecided; 1934–35, probably Rochester.

The revoking of the Federal Asiatic Beetle quarantine recently announced is a step toward a more conservative interpretation of the quarantine act, and while it may not be satisfactory to all interested, subsequent developments may justify the belief of the Department to the effect that a continuance of this is not justified by the information at hand. It is certain that a line must be drawn somewhere. We can not afford to pay more for the protection than it is worth, all things considered. An unfortunate phase of the quarantine situation is that no one can forecast the future with certainty respecting any introduced insect. It may become more injurious as time passes and on the other hand, it may soon occupy a relatively insignificant status.

The papers presented at the annual meetings indicate the widespread and general interest in the possibilities of biological control, especially those in relation to the rearing of egg parasites. The minute *Trichogramma* has been known for years, its fluctuations in numbers have been recognized and there is a possibility that rearing and liberation of this insect may prove of material service in controlling several destructive insects. The work in several localities with *Macrocentrus* is also promising. This is a relatively unoccupied field and it is reasonable to assume that the possibilities have by no means been exhausted in the case of the few insects which have been utilized for such purposes. There is at least a fair chance that other parasites and predators, some presumably almost unknown, may be found equally amenable to artificial rearing and utilization. It is hardly to be expected that biological control with

its attractive program can replace to any great extent the artificial control measures so generally employed. It may, however, prove a valuable aid in many cases and possibly our sole dependence for certain species not easily reached by poison or contract insecticides.

Obituary

Stephen Alfred Forbes

The death of Professor S. A. Forbes on March 13th brings to a close one of the most remarkable careers known in the history of American Entomology.

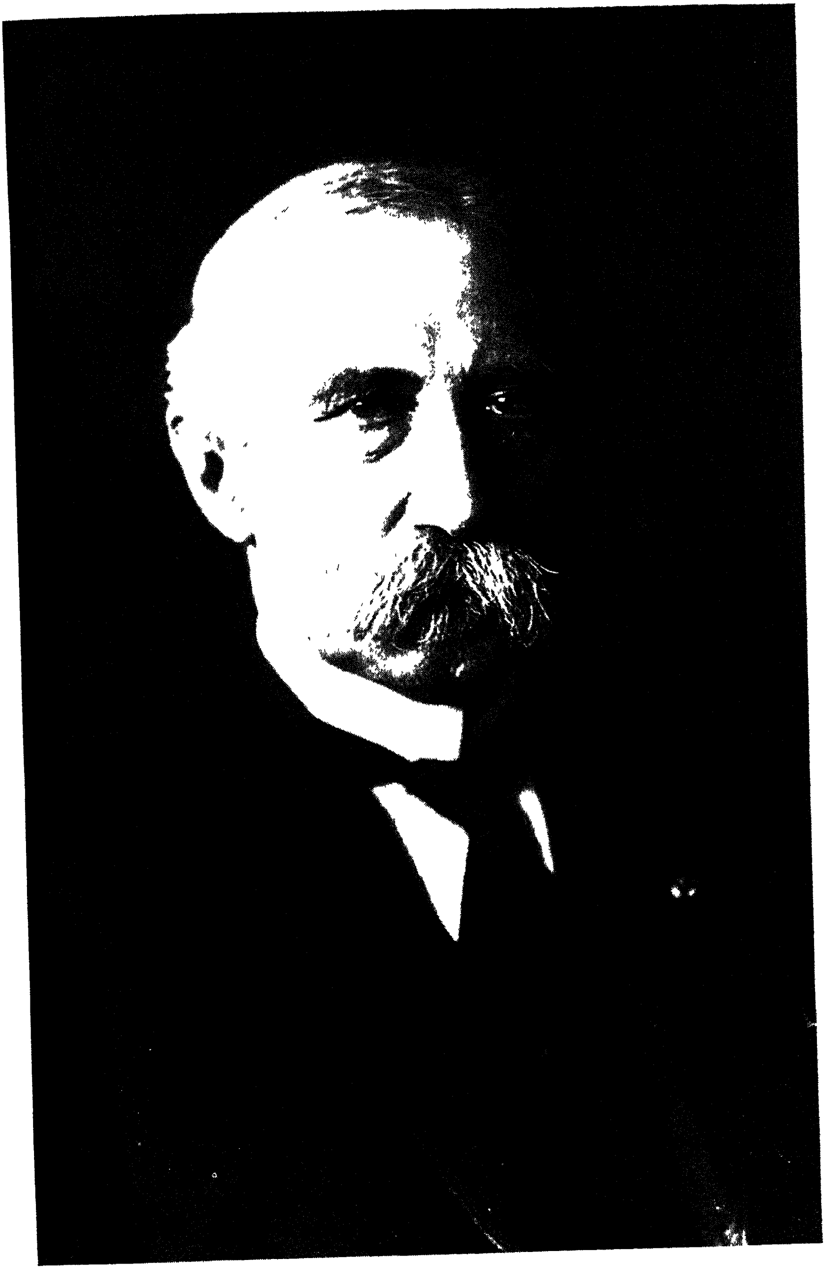
Born in 1844 (May 29), Captain in a cavalry regiment and four months a prisoner in confederate prisons during the civil war, he served his native state of Illinois during almost the entire eighty-six years of a busy life.

After student work in Beloit Academy and attendance at Rush Medical College, he began scientific work as Curator of the Illinois State Natural History Society in 1872 and taught Zoology in the State Normal University from 1875–78. He organized and was director of the State Laboratory of Natural History which was moved to Urbana when he became State Entomologist in 1882. In addition to the dual position of Director of the State Laboratory and State Entomologist, he was made Professor of Zoology and Entomology in the University in 1884, served as such until 1909 and as Head of the Department of Entomology from 1909 to 1921. He also served as Dean of the College of Science from 1888 to 1905.

He was no doubt most widely known outside his home state as Director of the State Laboratory and as State Entomologist, these offices being sufficiently distinct that outsiders not familiar with the local organization might easily have thought of two distinct individuals as in charge of these respective offices.

In Who's Who he is distinguished as "Naturalist" and he was in no sense a narrow "Entomologist" or even "Zoologist" as his biological interests covered many fields. With the reorganization of the work in 1917 he became Chief of the Natural History Survey which title he held until his death.

Among the many notable studies pursued in his laboratory, perhaps standing out most prominently are those upon the food of birds, the food of fishes, the biology of crustacea, the life history and ecology of the corn aphis and the insects injurious to the corn crop with extended attention to such pests as the corn root worm, chinch bug, Hessian fly and San Jose scale.



S. A. Forbes.

While his time was largely devoted to the organization and direction of research, his staff has included many men who sought contact with his organization as a means of perfecting their methods of work. F. M. Webster, Harrison Garman, Clarence M. Weed and Willis G. Johnson are names of a few of those who have contributed largely to entomological growth and who left his staff to assume positions of responsibility in other states.

He had the rare privilege of carrying his activities far beyond the average span of human life; of keeping in the harness until the very end of a remarkable career; of seeing the growth and maturity of many plans for scientific and educational progress and the fruition of policies of state and nation wide importance in entomological practice.

He was married December 25, 1873, to Clara Gaston Shaw, a union of marked felicity, and it is very probable that the shock of her recent death may have contributed to the illness that terminated his life.

He was a man of high ideals; a master of scientific analysis, an adept in the use of language, with a steadfast devotion to the duties of his office and recognition of obligation to the people of his state. Aside from the honors and confidence bestowed upon him by his native state, he was the recipient of many honors from societies in America and abroad.

The writer's personal acquaintance with Doctor Forbes goes back to 1883 when we met with the American Association for the Advancement of Science at Minneapolis. Our work, for many years in adjacent states, resulted in frequent correspondence and occasional conferences and his helpful suggestions and cooperation are remembered with sincere appreciation. It was Forbes who sent me a disease of cabbage worms to test at Ames. It was he who called a conference of entomologists from adjacent states to grapple with the San Jose scale problem and it was to his wider experience and mature judgment that I, with others of the younger workers in entomology, looked for leadership.

It is difficult to fully estimate today his influence on the development of entomology but he must be ranked as one of the great leaders in the growth of the science, a power not only in the state of his lifetime activity but in the nation and the world at large. In our tribute to his worth we take pride in his career and glory in the splendid achievements of a notable life.

HERBERT OSBORN

Current Notes

R. W. Brubaker, a senior student of Ohio State University, has been appointed Field Assistant in investigations of mushroom insects at Arlington, Va.

Mr. W. G. Mathers, Entomological Branch, of the Vernon B. C. laboratory, is at Syracuse University taking post graduate studies leading to the degree of master of s cience.

E. A. Back, Bureau of Entomology, was the guest of the National Furniture Warehousemen's Association at its convention held at the Edgewater Gulf Hotel, Biloxi, Miss., January 14 to 18.

P. N. Annand, Bureau of Entomology, formerly in charge of the sugar-beet leafhopper laboratory at Davis, Calif., has been transferred to Twin Falls, Idaho.

T. H. Jones and I. T. Guild, Bureau of Entomology, of the Gipsy-Moth laboratory, attended a meeting of the Northwestern Forest Research Council, at Springfield, Mass., on February 1.

George G. Ainslie, Bureau of Entomology of the field laboratory at West Lafayette, Ind., is spending several weeks in Washington, at the National Museum, working on the North American Crambidae.

Dr. B. B. Fulton, of the North Carolina Agricultural Experiment Station, at Raleigh, spent January 21 to 25 examining material in the collection of Orthiptera, with reference to a revision of the Orthoptera of Oregon.

F. F. Dicke, Bureau of Entomology, has accepted a transfer from the corn-borer laboratory at Monroe, Mich., to the field laboratory at Charlottesville, Va., where he will assist in investigations of the jointworm.

Prof. Herbert Osborn, research Professor of Entomology at Ohio State University was honored at the commencement of the University of Pittsburgh, February 10th, when the honorary degree of Doctor of Laws was conferred upon him by that institution.

N. F. Howard, Bureau of Entomology, attended a school for canners held on February 20 at the University of Maryland, College Park, where he took part in a discussion on the Mexican bean beetle.

Dr. R. T. Cotton, Bureau of Entomology, spent February 9 to 11 in Buffalo, N. Y., where opportunity was given him to check results of fumigations at the establishments of Larkin and Company and the Hecker H-O Cereal Company.

A. O. Larsen, Bureau of Entomology, of the bean-weevil field laboratory, Modesto, Calif., arrived in Washington on February 14, for consultation and work on manuscripts. In his absence C. K. Fisher is in charge of the laboratory.

On February 14 M. C. Lane, Bureau of Entomology, visited the Experiment Station officers of Idaho and Washington at Moscow, Idaho and Pullman, Wash., in the interest of the present season's work on wireworms in those States.

Mr. Ralph Hopping, Entomological Branch, arrived in Ottawa from Vernon, B. C. on Jan. 2, and will spend a considerable part of the winter months working with Dr. Swaine on the second half of the revision of the Lepturini.

R. Cecil, Geneva, N. Y. and J. R. Dougless, Estancia, N. M., both of the Bureau of Entomology, have been in Columbus, Ohio during the winter months to review with N. F. Howard their last season's work on the Mexican bean beetle.

W. D. Reed and Austin W. Morrill, jr., Bureau of Entomology, of the Dried Fruit Insect Laboratory, have been engaged in an investigation, in California, of such infestations of freight cars as are likely to affect shipments of dried fruits.

During the autumn, Mr. G. H. Hammond, Entomological Branch, encountered an unusually widespread outbreak of the fungus Cordyceps, in white grubs. In connection with this, a joint investigation is being carried on with Dr. J. E. Machacek, Mycologist at Macdonald College.

Miss Winifred Law, B.A., was appointed to the position of Junior Entomologist, Entomological Branch at Ottawa, dating from December 24. This position was made vacant by the promotion of Mr. Walley, sime time ago, to the position of Assistant Entomologist.

Mr. R. E. Balch, B.S.A., M.S., has been appointed to the position of Entomologist, Entomological Branch, and will take charge of forest insect investigations in the Maritime Provinces, with headquarters at Fredericton, N. B. Mr. Balch reported for duty early in February.

Mr. Paul D. Sanders, Associate Entomologist, Extension Service, University of Maryland attended the annual meeting of the New Jersey Mosquito Extermination Association held at Atlantic City, February 13, 14, and 15. Maryland is planning some extensive work on the mosquito problem in the Chesapeake Bay region.

L. W. Noble, Junior Entomologist, Bureau of Entomology, who has been a member of the force at Tallulah since his appointment in September, 1929, has been transferred to El Paso for work on the pink bollworm, and left Tallulah February 12.

H. J. Reinhard, of the Texas Agricultural Experiment Station, at College Station, has been engaged at the National Museum since January 25 on a study of the North American species belonging to the tachinid genus Winthemia. Before leaving Washington he expects to make substantial progress in a classification of these flies.

The grasshopper project has been reorganized, and Doctor J. R. Parker, formerly connected with the Department of Entomology of the Montana Agricultural College and Experiment Station at Bozeman, Mont., has been placed in charge of this work. The Laboratory at Billings, Mont., is being moved to Bozeman, where Doctor Parker will have his headquarters.

Mr. G. S. Walley, Assistant Entomologist, Entomological Branch, at Ottawa, is on three months leave of absence without pay, at the Iowa State College taking post graduate studies leading to the degree of doctor of philosophy. While there he will also make special studies of Hemiptera in connection with material from the Canadian National collection.

N. F. Howard, Bureau of Entomology, Columbus, Ohio, was in Washington February 8 to 21, to assist in miscellaneous work on manuscripts, including a revision of Farmers' Bulletin 1407, on the Mexican bean beetle, and a new manuscript on the Mexican bean beetle, prepared by L. W. Brannon and himself, to be published by the Virginia Truck Experiment Station.

The Department of Entomology, University of Maryland, has added Mr. R. E. Snodgrass of the Bureau of Entomology, Washington, D. C., to its teaching staff, part time, as Collaborating Professor of Entomology. Mr. Snodgrass is conducting a course in insect morphology, with special relation to function. This is a graduate course, offered to supplement the earlier training of the advanced students.

Cornelius B. Philip, who has recently been in Lagos, South Nigeria, working on the yellow fever investigations for the International Health Board of the Rockefeller Foundation, stopped in Washington, December 18 and 19 to compare some mosquitoes with material in the National collection. He was on his way to Montana, where he will undertake work on the Rocky Mountain spotted fever.

Mr. L. G. Gentner resigned his position as Research Assistant at Michigan Staet College, March 1, 1930, to take up similar work at Talent, Oregon. Mr. Gentner will be following the same type of work that he carried on in Michigan. Mr. Franklin Sherman III, of Cornell University has been appointed to take the place vacated by Mr. Gentner.

W. D. Reed, Bureau of Entomology, of the field laboratory at Fresno, Calif., went to Indio, Imperial Valley, on February 5 to advise and make fumigation tests for the Deglet Noor Date Growers Association. The delivery of dates begins about September 5 and lasts until about January 1. All dates are fumigated on receipt at the packing house, and most of them are again fumigated just before shipment.

The officers of the Chatham Ontatio Laboratory, Entomological Branch, are studying the winter mortality of the European corn borer, in standing stalks and below ground, both in the field and in the laboratory, and are making determinations of lethal temperatures for the larvae under various conditions, as part of the study of climatic limitations on the corn borer's distribution in Canada.

George B. Wagner, Bureau of Entomology, in charge of investigations of flour-mill insects, attended the Kansas Wheat Belt Conference held at Wareham Hotel, Manhattan, Kans., on November 9. It was there planned that Mr. Wagner should assist George Montgomery, of the Extension staff of the Kansas State Agricultural College, in the conducting of a number of grain-grading schools to be held in Kansas in April.

R. E. Campbell, Bureau of Entomology, Alhambra, Calif., has been granted a furlough to undertake special studies at the University of Minnesota, St. Paul, beginning in January, 1930. He visited Washington, D. C., on December 17, for conference in regard to the pepper weevil and wireworms in California. En route to St. Paul, Minn., from Washington, he stopped over at Columbus, Ohio, and attended the entomological meetings at Des Moines, Iowa.

On February 21 the field laboratory at Biloxi, Miss., was visited by five officials of the State Plant Board of Mississippi, these being Dr. L. E. Miles, Pathologist, J. M. Langston, Entomologist, and three Inspectors, R. P. Colmer, H. Gladney, and Henry Deitrich, located respectively at Moss Point, Ocean Springs, and Lucedale. On February 25 the same field laboratory had as a visitor C. E. Smith, in charge of the field laboratory at Baton Rouge, La.

Mr. Paul D. Sanders, Associate Entomologist, Extension Service, University of Maryland, has returned to the campus after five months leave. Mr. Sanders has completed his residence for the Doctor's degree, at Harvard University. Six weeks

of his leave were spent at the Harvard University. Six weeks of his leave were spent at the Harvard Tropical Research Station, at Soledad, Cuba. His collection of tropical insects, largely from Cienfuegos and surrounding Cuban territory have been presented to the University of Maryland, and will be incorporated in the collection at an early date.

In response to a request from the citrus growers of northern California, E. A. McGregor, Bureau of Entomology, of the field laboratory at Lindsay, Calif., went to Oroville, where on January 16, he addressed the growers on the subject of control of the citrus thrips. This address was a part of the Citrus School program of that date. Particular stress was placed by Mr. McGregor on the part that dusting with finely ground sulphur is playing in the control of this insect in central California.

Mr. E. Graywood Smyth, formerly of the Bureau of Entomology, and for several years entomologist of the Insular Agricultural Experiment Station in Porto Rico, has accepted a contract position as entomologist for W. R. Grace and Company on their sugar estates in Peru. Until recently he has been employed as entomologist for John Powell and Company, Pyrethrum Specialists, in New York City. His permanent address will be Hacienda Cartavio, Salaverry, Peru, and he will devote himself largely to the control of the sugar cane moth stalk borer, *Diatraea saccharalis*.

Perez Simmons, Bureau of Entomology, in charge of the field laboratory at Fresno, Calif., for the study of dried-fruit insects, writes that the periodical exchange which he started last year has been reogranized for 1930. This year 16 laboratories of the Bureau on the Pacific Coast are cooperating. "There are 446 numbers, of 35 periodicals, in the exchange. Assuming that but one man at each station to which a periodical is sent, reads it, the exchange will be equivalent to 1,047 individual loans of periodicals."

The ninth annual conference of the North Central States Entomologists was held at Purdue University, Lafayette, Indiana, March 5 and 6. Eighty persons (not including students and members of other departments) from 15 states and from Canada registered. Informal discussions of the important insect problems of the north-central states occupied the greater part of the two days. The annual dinner was held the night of March 5, Dr. Edward C. Elliott, President of Purdue University, acting as toastmaster. J. J. Davis acted as chairman of the Conference. The next meeting (March, 1931) will be held at Urbana, Illinois.

On February 27 William Middleton, Forest Insect Investigations, and Dr. Floyd F. Smith, of the Division of Cereal and Forage Insects, both of the Bureau of Entomology, visited Leesburg, Va., to demonstrate the fumigation control of the boxwood leaf miner, with which they have been experimenting for several years. The demonstration was conducted at the request of Mr. Lintner, County Agent of Loudoun County, who has succeeded in arousing in that county a great deal of interest in boxwood and in the control of the leaf miner.

D. E. Fink, Bureau of Entomology, in charge of the field laboratory at Philadelphia, Pa., advises that Dr. Jaymie R. Peirera, Professor of Pharmacology of Sao Paulo Medical School, Sao Paulo, Brazil, visited his laboratory on January 13, to obtain first-hand knowledge of the "Electro-Gutzeit Apparatus" perfected at this laboratory. This apparatus has been the subject of inquiry from State experiment stations, entomologists, chemical companies, and the Research Institute, Mel-

bourne, Australia. Word has been received that Dr. N. F. True, chief chemist for Mead, Johnson and Co., Evansville, Ind., has had a similar apparatus constructed for work in infant diet.

A large shipment of cocoons of the oriental hag moth, *Cnidocampa flavescens* Walk., reached the Gipsy-Moth Laboratory on February 13. The shipment consisted of approximately 779,000 cocoons collected in Fuji and Mikawa, Japan, under the direction of T. R. Gardner, of the Bureau's Japanese and Asiatic Beetle Investigations. Over 600 Japanese school children participated in the collecting, and Mr. Gardner writes that examination of sample lots of cocoons showed that nearly 50 per cent contained larvae of the tachinid parasite, *Chaetexorista iavana* B & B. It is hoped that the liberation of admits of this parasite made last year in infestations of *Cnidocampa flavescens* in the vicinity of Boston, together with those which it should be possible to make this year, will result in its establishment.

The annual conference of Federal and State administrative officials, scientists, and others, on the research program for the control of the European corn borer was held at the Department of Agriculture in Washington, D. C., February 11. The complete research program for the year, and reports of several committees on important phases of the work, were presented and considered. The purpose of this meeting, as heretofore, was to provide for a complete coordination of the various projects, both Federal and State, for research on the corn borer, to arrange for desirable replication of experiments and to prevent unnecessary duplication of experimental work. It was further intended to have this direct contact with the program for research on the corn borer afford an opportunity for administrative review and constructive criticism, to the end that the program should each year be in every respect as complete and satisfactory as possible.

On February 21 R. A. St. George, Bureau of Entomology, received a report from S. R. Broadbent, Supervisor of the Unaka National Forest, with headquarters at Bristol, Tenn., that an outbreak of the southern pine beetle has been located along Scioto Creek. The attack of the beetle was made last fall, and the overwintering brood was recently discovered. This information is of particular interest, since similar attacks in the French Broad Division of the Pisgah National Forest and adjoining tracts also occurred last fall, and have now resulted in heavy broods of this beetle. The trees in both forests along the boundary between western North Carolina and eastern Tennessee were probably attacked at about the same time. The low temperatures of November 29 and 30, 1929, were effective in killing the brood that remained between the bark and the wood, but the more developed brood that had penetrated the outer bark escaped being affected. Unless zero temperatures are experienced in March, or excessive rainfall occurs this spring, there is apt to be a rather heavy emergence of the beetles early in the summer.

Conferences were held in Washington, D. C., February 10, 1930, in Room 411, Bieber Building, on the Codling Moth and Peach Moth. The following were present: E. N. Cory, H. S. McConnell, G. S. Langford, P. D. Sanders, W. T. Henerey and P. K. Harrison, Univ. Md.; W. S. Hough, Va. Agr. Exp. Sta.; Geo. A. Dean, Kan. Agr. Coll.; C. H. Alden, Ga. State Bd. Ent.; J. S. Houser, R. B. Neiswander and L. L. Huber, Ohio Agr. Exp. Sta., T. J. Headlee and B. F. Driggers, N. J. Agr. Exp. Sta.; T. L. Guyton and J. R. Stear, Pa. Bureau Plant Ind.; H. N. Worthley, S. W. Frost and H. E. Hodgkiss, Pa. State Coll.; L. A. Stearns, Del. Agr. Exp. Sta.; Philip Garman, Conn. Agr. Exp. Sta.; J. J. Davis, Purdue Univ.; R. H Pettit Mich.

Agr. Coll.; D. M. Daniel, N. Y. Agr. Exp. Sta.; L. M. Peairs, W. Va. Agr. Exp. Sta.; C. O. Eddy, S. C. Agr. Exp. Sta.; W. A. Ross, Ont. Agr. Coll.; R. B. Arnold, Tobacco By-Products & Chem. Corp.; C. G. Woodbury, Natl. Canners' Association; A. L. Quaintance (Chairman), L. C. McAlister, Jr., Loren B. Smith, B. A. Porter, Luther Brown, E. H. Siegler, J. W. Lipp, F. H. Lathrop, Wm. P. Yetter, Jr., H. W. Allen, E. J. Newcomer, G. A. Runner, J. L. King, F. L. Campbell, and F. M. Wadley, U. S. Bur. Ent.; M. B. Waite, J. R. Magness and H. C. Diehl, U. S. Bur. Plant Ind., and R. C. Roark and C. M. Smith, U. S. Bur. Chem. & Soils. Minutes of the conferences will be issued in mimeographed form and sent to those in attendance. Upon request the minutes will also be sent to others interested as long as the supply lasts.

Horticultural Inspection Notes

Mr. George M. Jones was transferred from Laredo, Texas, to assume charge of the work at the Port of Zapata, Texas, on March 4, 1930.

That part of Baldwin county, Alabama, formerly restricted under the State sweet potato weevil quarantine, was released on January 14, 1930, from such restriction.

Mr. C. W. Shockley was transferred from the Pink Bollworm project to the Mexican Border service on March 10, 1930. Mr. Shockley has been assigned to the Port of Brownsville, Texas.

The Memphis, Tenn., transit inspection station, for the purpose of aiding in the enforcement of the phony peach disease quarantine, was discontinued for the season on February 20.

Mr. R. B. Haller who has been stationed at Del Rio, Texas, for several years was put in charge of the Plant Quarantine and Control Administration's activities at the port of entry at Roma, Texas, on February 1, 1930.

Mr. R. N. Dopson, assisting in the enforcement of the phony peach disease quarantine and in transit inspection work at Birmingham, Ala., was transferred to Chicago on March 3 and was succeeded at Birmingham by C. E. Martin.

A quarantine against the transportation into California of hop sets, hop roots, and hop cuttings from all States except Oregon, has been issued by the Director of Agriculture of California, effective January 31, 1930.

On March 3, the Pennsylvania Railroad was fined $1400 for violations of quarantines on account of the Japanese beetle, Asiatic beetle and Asiatic Garden beetle, involving the transportation of seven carloads of soil from New Jersey to Michigan.

Mr. G. W. R. Davidson, in field charge of the enforcement of the Federal phony peach disease quarantine, made a study during March of the desirability of undertaking transit inspection at Texarkana and New Orleans in connection with the administration of this quarantine.

Mr. R. H. Bell, Director of the Bureau of Plant Industry of the Pennsylvania Department of Agriculture was incapacitated for several weeks during January and February and unable to be at his office. Mr. T. L. Guyton was made Acting Director for the period of Mr. Bell's absence.

Mr. Claud H. Wallis, Mr. C. F. Haller and Mr. Keim E. Miller were appointed Junior Plant Quarantine Inspectors and assigned in February, 1930, for duty at the Port of Nogales, Arizona, the Port of El Paso, Texas and the Port of Roma, Texas, respectively.

A sub-committee of the Appropriations Committee of the House of Representatives spent about two weeks in Florida late in February and early in March conducting a hearing on the Department of Agriculture estimates for the continuation of the Mediterranean fruit fly eradication and quarantine work.

On February 8, 1930, the Plant Quarantine and Control Administration issued "Supplement No. 2 to Instructions on the Disinfection of Nursery Products for the Japanese and Asiatic Beetles." This supplement changed the specifications for the disinfection of soil about the roots of plants with carbon disulfide emulsion.

Mr. J. S. Wieman has been appointed nursery inspector at large by the Oregon State Board of Horticulture. This is a new position for which an appropriation was made at the last session of the legislature. Mr. Wieman's duties will include nursery inspection and the assistance of nurserymen in the control of plant diseases and insect pests.

The California Department of Agriculture revised the State Oriental fruit moth quarantine, effective January 31, 1930, to add the States of Rhode Island, Massachusetts, and Michigan to the list of those from which the fruits, trees, and parts thereof, of apple, peach, cherry, etc., and the used containers of such fruits, are not admissible into California.

The Oregon Alfalfa Weevil quarantine has been amended to allow the shipment of alfalfa meal from weevil-infested States throughout the year provided the meal is ground in mills built on plans approved by the Bureau of Entomology alfalfa weevil specialists at Salt Lake City.

Mr. Charles A. Cole, Secretary of the Oregon State Board of Horticulture, reports that a quarantine order against the bringing in of hop roots from all States except California has been issued by the State of Oregon. The quarantine was adopted for the purpose of preventing the introduction of the Hop Downy Mildew which is now present in Colorado and has been reported in the past in various parts of the United States.

Dr. Walter A. McCubbin, Plant Pathologist of the State Department of Agriculture at Pennsylvania, was appointed on February 1 to take charge of the certification of Florida products for intrastate and interstate movement under the Federal and State quarantines on account of the Mediterranean fruit fly. This position involves supervision of the work at packing houses, storages, canneries, and all other details connected with the issuance of permits in Florida under the fruit fly quarantine.

The pink bollworm infestation in the Salt River Valley of Arizona, which was discovered October 4, 1929, appears to be confined to that portion of the Valley east of Tempe. A noncotton zone has been established by the State covering a total of 144,400 acres. Within this area 35,000 acres were planted to cotton in 1929. The noncotton zone is surrounded by a protective or buffer zone which extends three miles beyond the noncotton zone. Congress has passed an appropriation of $587,500 for the cleanup of the cotton fields throughout the noncotton zone and in some parts

of the buffer area. Provision is also being made for compensation to the farmers in the noncotton zone area.

As a result of the discontinuance by the U. S. Department of Agriculture of the Mediterranean fruit fly field inspection work in Florida, Dr. Wilmon Newell, who has been the Federal administrative agent in carrying on this work, has resigned his Federal position and the Government regulatory work in connection with fruit fly activities in Florida has been placed under the direction of Dr. W. C. O'Kane, chairman of the Federal Fruit Fly Board, it was announced to-day by Lee Strong, Chief of the Plant Quarantine and Control Administration. The department continues cooperation with the Florida State Plant Board, of which organization Doctor Newell is the executive officer. Doctor O'Kane has been chairman of the Federal Fruit Fly Board since its creation by Secretary Hyde on January 9.

Early in February the Plant Quarantine and Control Administration made arrangements for the certification of the reshipment of Florida sterilized host fruits and host vegetables from Washington, Baltimore, and Pittsburgh to points in Virginia, West Virginia, and Ohio. Such certification at Washington was placed under the direction of the Administration Inspection House; that at Baltimore is being handled by J. W. Kelley, formerly of the Japanese Beetle inspection service; while work at Pittsburgh is under the direction of Clyde B. Beamer. Four crews of two men each were assigned to road station work at the southern and western boundaries of Maryland and Pennsylvania to enforce the requirements.

The Southern Plant Board met at Jackson, Mississippi on February 5 and 6, 1930, in connection with the Annual Session of the Southern Agricultural Workers. The following States were represented: Texas, Oklahoma, Louisiana, Mississippi, Alabama, Georgia, South Carolina, North Carolina, and Tennessee. Mr. E. R. Sasscer and Mr. R. E. McDonald of the Plant Quarantine and Control Administration were also present. The subjects discussed included foreign plant quarantines, the unification and coordination of nursery inspection in the south, Mediterranean fruit fly, pink bollworm, and phony peach disease. The following are the officers for the ensuing year: B. P. Livingston, President; Paul Millar, Vice-President; M. S. Yeomans, Secretary-Treasurer; R. W. Harned, and R. W. Leiby, representatives on the National Plant Board. The next meeting is to be held at Atlanta early in February, 1931.

The Federal quarantine on account of the Japanese beetle was revised, effective March 1, to extend the regulated area to include one county in Massachusetts, as well as certain new territory in Connecticut, New York, Pennsylvania, Maryland, Delaware, and Virginia. Under this revision the regulated area is divided into generally and lightly infested areas. Restrictions on the movement of farm products apply to such movement from the generally infested areas but do not affect the movement of these articles from the lightly infested area. The shipment of other restricted articles both from the generally infested to the lightly infested area and from either to points entirely outside the regulated areas, is restricted under this modification. A further change of interest to shippers increases the classes of bulbs exempt from Japanese beetle certification.

The Federal quarantine on account of the Asiatic Beetle and the Asiatic Garden beetle was revoked by the Secretary of Agriculture, effective March 1, 1930. The area affected consisted of the District of Columbia, the State of New Jersey, anP

portions of Connecticut, New York, Pennsylvania, and Virginia. In announcing the revocation of the quarantine, the Secretary stated that "the Department of Agriculture has reached the conclusion that a continuation of Federal restrictions on the interstate movement of nursery products and soil, to prevent the spread of these insects, is not justified by the information at hand. In placing the quarantine a year ago, the Department felt that dissemination should be prevented until the significance of these species could be weighed more carefully and further observations made. The past year's work has indicated that their potential danger to the United States does not justify the expenses of quarantine administration and the losses resulting from the imposition of restrictions. In revoking this quarantine, the Department of Agriculture is following the precedents of past years in removing plant quarantine restrictions whenever it becomes apparent that they are no longer justified by the available facts."

Recent orders issued by the Plant Quarantine and Control Administration with respect to the transportation of Florida host fruits and vegetables include the following: PQCA-261, "Diversion Restrictions on Florida Host Fruits and Vegetables Modified"; PQCA-262, "Period of Movement of Host Fruits and Vegetables from Florida to Southern and Western States Extended to February 28, 1930"; PQCA-263, "Modification of the Restrictions on the Movement of Florida Host Fruits and Vegetables from the District of Columbia and the States of Maryland and Pennsylvania to Nearby Points in Virginia, West Virginia and Ohio"; PQCA-264, "Extension of Production and Harvesting Period of Florida Cantaloupes to June 15, 1930"; PQCA-266, "Waterproof Fabric Mesh Bags Authorized as Containers for Florida Host Fruits and Vegetables"; PQCA-267, "Production of Cotton in and Intrastate Movement from Eradication Areas in Florida"; PQCA-268, "Release of West Florida from Mediterranean Fruit Fly Quarantine Restrictions"; PQCA-269, "Extension of Production and Harvesting Period of Florida Citrus and Other Host Fruits to April 15, 1930"; PQCA-270, "Florida Host Vegetables Produced Outside Eradication Area Authorized to be Shipped by Express in Less Than Car Lots"; and PQCA-271, "Additional Method of Sterilizing Florida Citrus Fruits by Refrigeration, Authorized."

The sixth annual meeting of the Central Plant Board was held at Lafayette, Indiana, on March 6, 1930. Nine States: Iowa, Illinois, Indiana, Kansas, Michigan, Minnesota, Missouri, Ohio, and Wisconsin were represented. On account of the apparent wide distribution of Rose yellows, a resolution was passed asking the Federal Department of Agriculture to make an investigation to determine its distribution, and to determine the sources from which healthy American grown stock can be procured, and requesting the Plant Quarantine and Control Administration not to prohibit the importation of foreign grown rose stock until such investigation has been completed and sources from which an adequate supply of rose stock free from yellows can be procured. The members of the Board are unanimous in the belief that the Mediterranean fruit fly will never become a serious pest in any of the north central States and that it probably will not be able to maintain itself very far north of the Gulf Coast. The Secretary was asked to renew the request of a year ago that Plant Quarantine No. 38 be amended so as to prohibit the interstate movement of the Mahonias, except *Mahonia repens*, between the thirteen States which are engaged in the eradication of the common barberry because the Mahonias are not being eradicated in some of the States. The next place of meeting is Urbana,

Illinois. The officers for the next year are: E. L. Chambers, President; P. A. Glenn, Secretary and Treasurer; Geo. A. Dean and A. G. Ruggles, members of the National Plant Board.

The National Plant Board held its annual meeting at Orlando, Florida on January 11 to 15, 1930. The full membership was present as follows: W. C. O'Kane, Durham, N. H. (Chairman); G. A. Dean, Manhattan, Kansas (Vice-chairman); W. A. McCubbin, Harrisburg, Pa. (Secretary); Oscar Bartlett, Phoenix, Arizona; R. W. Harned, A. & M. College, Mississippi; W. C. Jacobsen, Sacramento, California; R. W. Leiby, Raleigh, N. C., and A. G. Ruggles, St. Paul, Minnesota. The Board spent a part of its sessions investigating the Mediterranean fruit fly problem and concluded that "this pest shows potentialities for damage so great that it should be suppressed at almost any cost"; * * * "That this program undertaken by the PQCA and the Florida State Plant Board not only effectively safeguards the rest of the country from this pest but gives an assuring prospect of its ultimate eradication * * * [and that] the National Plant Board earnestly urges the PQCA and the Florida Plant Board to continue their eradication efforts on both an extensive and intensive scale until the final suppression of this pest is absolutely assured." Final agreement among the various States on certain principles relating to nursery inspection methods was announced, and seven such principles were recommended for adoption by all States. Other subjects discussed were larch canker, the Salt River Valley outbreak of the pink bollworm, the importation of foreign fruits through northern ports and their possible reshipment south; the danger of airplanes being responsible for pest introduction; terminal inspection of parcel post; the increasing spread of the Argentine ant, and the fumigation of nursery stock. It was further announced that for several years the Board has had under preparation a statement embodying the "Principles of Quarantine," and that this statement has now been submitted to the Regional Boards for consideration.

Apicultural Notes

Mr. Charles A. Reese, State Bee Inspector, Columbus, Ohio, attended the American Honey Producers' League, February 4, 5, and 6, which was held at Milwaukee, Wisconsin.

J. E. Eckert, Bureau of Entomology, of the Intermountain Bee Culture Field Laboratory, Laramie, Wyo., attended the meeting of the Wyoming Beekeepers' Association at Thermopolis, Wyo., on December 12 to 14, and addressed the meeting on "The flight range of the honeybee."

C. E. Burnside and W. J. Nolan, Bureau of Entomology, attended the annual meeting of the Maryland State Beekeepers' Association, in Baltimore, on January 8th. Doctor Burnside spoke on "The present status of American foulbrood control," and Mr. Nolan gave a talk on "Races of honeybees."

Dr. A. P. Sturtevant, Bureau of Entomology, in charge of the Intermountain Bee Culture Field Laboratory, Laramie, Wyo., attended the meeting of the Idaho State Beekeepers' Association, and the conference of apiary inspectors, at Buhl, Idaho, December 16 and 18. Doctor Sturtevant spoke on "The various problems associated with apiary inspection."

The Ohio Beekeepers' Association at their convention held at the Ohio State University, February 6, 7, and 8 went on record as opposing the Corn Sugar bills, Senate Bill (S-685) and House Bill (H.R. 2154). This bill if passed would leaglize corn sugar being mixed with any other sweet without the declaration of such on the label.

W. J. Nolan, Bureau of Entomology, attended the annual meeting of the New Jersey State Beekeepers' Association, at Trenton, on January 16 and 17, and spoke on "The United States honey grades," and "The work of the Bee Culture Laboratory." On January 21 and 22 he attended the annual meeting of the Pennsylvania State Beekeepers' Association, at Harrisburg, where he gave a talk on "Characteristics of the various races of honeybees," and also acted as judge of the apiary products at the Farm Show.

Dr. Warren Whitcomb, jr., Bureau of Entomology, of the Southern States Bee Culture Field Laboratory, Baton Rouge, La., attended the meeting of the Alabama State Beekeepers' Association at Montgomery, Ala., on November 7 and 8. After the meeting Doctor Whitcomb, accompanied by L. T. Floyd, Provincial Apiarist of Manitoba, and H. C. Short, President of the Alabama State Beekeepers' Association, visited a large number of the queen breeders and package-bee producers in the heart of the package-bee industry in Alabama.

Jas. I. Hambleton, after attending the meetings of the American Association for the Advancement of Science at Des Moines, Iowa, visited the Intermountain Bee Culture Field Laboratory, at Laramie, Wyo., he then went to the beekeeping centers of the Pacific Coast States. He returned by way of Baton Rouge, La., where he visited the Southern States Bee Culture Field Laboratory, and attended the meetings of the American Honey Producers' League in Milwaukee, Wis., on February 3 to 6. Mr. Hambleton then attended the meeting of the Ohio State Beekeepers' Association at Columbus, Ohio.

W. J. Nolan, Bureau of Entomology, attended the Extension School of the Department of Horticulture of West Virginia University, at Inwood, W. Va., on February 10, and gave a talk on "The use of bees in orchards for pollinating purposes." It is noticeable that fruit growers are giving more attention to the artificial control of pollination in orchards by the use of honeybees than they have given in the past. At the present time many of the producers of package bees are making arrangements to furnish exclusively package bees for purposes of pollination.

The Ohio Beekeepers' Association held their Winter Meeting, February 6, 7, and 8 in conjunction with Farmers' Week at the Ohio State University. The officers elected for the coming year were: E. E. Agler, Columbus, President; Alan Eby, West Elkton, Ohio, Vice-President; W. E. Dunham, Columbus, Secretary and Treasurer. Speakers outside the state included Dr. James I. Hambleton, Director of the Bee Culture Laboratory, Washington, D. C.; Dr. E. F. Phillips, Professor of Apiculture, Cornell University; Mr. Frank C. Pellett, Associate Editor of American Bee Journal, Hamilton, Ill., Dr. H. E. Barnard, President of the American Honey Institute, Indianapolis, Indiana; Morley Pettit, Georgetown, Ontario and Frank Todd, in charge of Apiary Inspection in California.

On a recent trip to the Pacific Coast Jas. I. Hambleton, Bureau of Entomology, stopped at the Oregon Agricultural College, at Corvallis, and at several branches of the University of California, as well as at a number of high schools and junior colleges, all of which are vitally interested in the future of beekeeping research, and have offered the Department of Agriculture excellent facilities and accommodations for carrying on research at their respective institutions. The exact location for a research laboratory on the Pacific Coast has not been selected. Cooperation on the part of beekeepers is also assured, and a number of the county associations as well as individual beekeepers have offered the use of their apiaries and other facilities for investigational work.

At the annual convention of the American Honey Producers' League, held in Milwaukee, Wis., February 4 to 6, a resolution was adopted asking the Department of Agriculture to appoint extension specialists in apiculture. The Association of Apiary Inspectors of America, which held its annual meeting at the same time, adopted a resolution requesting that reports on the occurrence and distribution of American foulbrood, and the progress made in its eradication, be included in the Insect Pest Survey. As soon as the machinery is perfected for reporting the findings on American foulbrood to the Insect Pest Survey the information should be very helpful in giving a clear-cut picture of the situation as to bee diseases in the United States, and enable the industry to see what progress is being made.

W. J. Nolan, Bureau of Entomology, has just attended the Southern States Beekeepers' Conference held at Baton Rouge, La., February 26 to 28, and reports a splendid meeting, with representatives present from 17 states. Mr. Nolan spoke on "Federal work of aid to the beekeeper." Dr. Warren Whitcomb, Jr., and Dr. E. Oeretel, of the Southern States Bee Culture field laboratory, also addressed the meeting, their respective topics being "Standardization of shipping cages for package bees," and "The number of egg tubules in the queenbee." Dr. E. F. Phillips, George S. Demuth, and Kenneth Hawkins, all formerly connected with the Bee Culture Laboratory, were present and appeared on the program. Dr. H. E. Barnard, President of the American Honey Institute, gave a talk on the nutrition of children, with special reference to honey. The next meeting of the Southern States Beekeepers' Conference will be held at Montgomery, Ala.

Notes on Medical Entomology

W. G. Bruce, Bureau of Entomology, went from Dallas, Tex., to Sanford, Fla., in the first week of January, where he has undertaken a survey of conditions relating to the cattle grub.

From January 20 to January 26 H. S. Peters, Bureau of Entomology, was engaged upon an investigation of the cattle grub at Burkes Garden, Va., with particular reference to control by local residents. The work was done in cooperation with L. I. Case, Extension Animal Husbandman, V.P.I.

F. C. Bishopp early in January went to the region of Sheboygan Falls, Wis., where he conferred with county agents and addressed meetings of farmers in regard to control of the cattle grub. He also conferred with the county agent, and with farmers at Gold Hill, Iowa, concerning a local program for the eradication of horse bots.

D. G. Hall, Bureau of Entomology, engaged in investigations of the eye gnat, writes that a careful study of the literature indicates that the generic name Hippelates has been incorrectly used. "The change is noted by Bezzi, 1928, Diptera of the Fiji Islands, British Museum Natural History, p. 148. Bezzi states "Doctor Kertesz (Ann. Mus. Nat. Hung. XII, p. 674, 1914) from an examination of the genotype, in the British Museum, states that Cadrema Walker, 1860, must be substituted for Hippelates, Loew, 1863."

F. C. Bishopp, Bureau of Entomology, left Washington February 3, to attend the meeting of the Southern Agricultural Workers, at Jackson, Miss., February 5–7. After this meeting he visited the field laboratory at Tallulah and New Orleans, La., and Sanford and Orlando, Fla., and conferred at Baton Rouge with members of the Division of Animal Industry of the Louisiana State Experiment Station.

JOURNAL
OF
ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

VOL. 23 JUNE, 1930 No. 3

Proceedings of the Forty-Second Annual Meeting of the American Association of Economic Entomologists Section of Plant Quarantine and Inspection

Monday Morning Session, December 30, 1929

The first session of the Section of Plant Quarantine and Inspection of the Forty-second Annual Meeting of the American Association of Economic Entomologists, held at the Hotel Savery, Des Moines, December 30, 1929 to January 1, 1930, was called to order at nine-fifty o'clock, Mr. Frank N. Wallace, Chairman of the Section, presiding.

CHAIRMAN WALLACE: Please come to order. The first business on our program is the appointment of committees.

Nominating Committee: R. W. Harned, L. S. McLaine and P. A. Glenn.

Resolutions Committee: G. A. Dean, K. C. Sullivan and A. C. Fleury.

I am going to ask Mr. McLaine to take the chair.

Mr. L. S. McLaine took the chair.

CHAIRMAN McLAINE: The next item on the program is the address by the Chairman of the Section, Mr. Wallace.

SOME FUNDAMENTAL QUALIFICATIONS FOR REGULATORY EMPLOYEES

By FRANK N. WALLACE, *Indianapolis, Ind.*

ABSTRACT

The important qualifications are an adaptable, pleasing personality, patience and perservance, supplemented by good judgment, and agricultural background and general college training.

It seems to me that we are passing through a transition period in regulatory work. The general public is not yet convinced of the necessity or the legality of some of our acts. However, they do believe in our sincerity of purpose and are willing to accept our word for the necessity of some of the things we do.

It is generally recognized that a law inefficiently enforced soon loses the respect of the people and becomes a dead letter. I have a firm belief in the need of quarantine laws but do not believe that these laws, enforced by inefficient or surly employees, will continue to have the respect of the people, even if they are just and needed.

We have travelled fast in the past ten years and sometimes we have been on thin ice. The public has been breathless at some of our stunts. In the near future we will have to improve in our technique or stay a little closer to the shore; perhaps do both. My opinion is that we must acquire better men and adopt saner methods in the next decade than we have in the past.

We cannot afford to make mistakes just now with this growing doubt in the minds of some of our citizens as to the legality or necessity of some of our actions.

Wherever we met with antagonism in any of our lines of work in Indiana, I made an effort to analyse the situations in hopes of preventing future trouble.

In almost every instance where we have had difficulties it seemed to me that if the situation had been diplomatically handled from its inception we would have not had any trouble. It helps to have a few efficient men as leaders but I believe we need and must have all of our employees well trained and with an abundance of horse sense.

I have taken up this subject because one entomologist, whom I regard very highly, recently made this statement about a man in our employ. "He is too good a man for regulatory work." It is possible that others feel that way about regulatory work and I would like to know how general this feeling is held throughout the country.

In other meetings we have listened to some excellent addresses on the training and educational requirements of entomologists. I have always agreed that the principles laid down were fundamental and sound for men in research work. However, I have doubted if that training was all that was necessary for a man in regulatory work. *Can* applicants for regulatory positions be judged by their entomological training alone?

I think that there are many qualities necessary for a man to possess for him to be a success along this peculiar line of work. I am going to give you my own ideas on this subject, hoping that others, better qualified than I, will set up a standard whereby applicants can be judged. It has always been my belief that when the right man was put on the job, that job was half completed. If those of us who are responsible for a department such as we have in Indiana can find the men qualified for

the work, then our part will only be to determine our policies and see that the proper laws are passed and that sufficient money is appropriated for the needs of our departments.

I will now give you what I consider the specifications for an ideal regulatory entomologist.

To me the most important qualification is an adaptable, pleasing personality. A regulatory man meets several thousand people in a year. He meets young and old, rich and poor, educated and illiterate. All of them are citizens and are entitled to his services. He must meet them on an equal basis and must win their confidence, even though he requires them to do things which they believe unnecessary or inconsequential. He cannot do this without a pleasing personality.

He must have patience and lots of it. Job with all of his boils is a poor object lesson when you consider a regulatory man on corn borer control work.

He must have perseverence. It is discouraging to work for five years in one community trying to persuade farmers to cut corn six inches lower than is customary. Possibly it is irritating to try to convince a berry grower that it is necessary to rogue out mosaic-infected plants.

He should have a fundamental knowledge of the rights of the public and a keen discrimination between liberty and license. He must realize that he is vested with very broad authority but that authority should be used with discrimination. This, however, could be acquired by a careful study of the principles of quarantines as written by Dr. W. A. McCubbin. I consider this a most remarkable presentation and we as regulatory men will never go very far wrong if we follow out the principles laid down by him.

He should have some business judgment, a sense of proper proportions between costs and possible benefits to be derived from his recommendations.

He should have had specific training. This includes more than the accepted entomologist's training. I consider the necessary training to commence during the boyhood days.

If during his boyhood days he had lived on a farm it would give him an understanding of farm problems that would be difficult to acquire in any other way. Working on a farm during summer vacations would help him make up this deficiency if the boy had been raised in a city.

If he had taken a scientific course in High School this would help.

Then, when he entered college start in on a modified agricultural course. In giving my ideas about these four years I expect to be told

it is not practical and that it cannot be done. However, I am thinking in terms of regulatory work and not college curriculum.

Spend twelve hours in English; twenty hours in Chemistry; six hours in Physics; six hours in Geology; three hours in Public Speaking.

Give him all of the theoretical agricultural subjects; crops, three hours; soils, three hours; floriculture, six hours; forestry, six hours; olericulture, three hours; horticulture, fifteen hours.

Then give him all the biology possible.

In determining an applicant's fitness for a particular job it would be impossible to determine all of these points in an interview of an hour or so. Could not the college teachers in the early years of contact with the students more easily and correctly detect these attributes? Detection and development of these peculiar traits along with the necessary scientific training would give us the ideal regulatory man. However, there are some other phases that must be considered before we can expect students to take special training for our work.

Certainly an applicant for a position who expected to follow regulatory work must be assured of the stability of the position. Certainly he should not fear that a change in an administration would throw him out of office. Heretofore, in many States this has happened. He must be assured that this will not happen in the future. When the public becomes accustomed to the proper type of man for these positions it will be improbable that the politicians could ever hope to furnish the man with the necessary qualifications. As to the future of the man in regulatory work, assurance must be given that adequate reward will be offered for the man who selects this field.

In Indiana we are gradually increasing the maximum paid to our assistants. Fifteen years ago our law set $1,500.00 as the upper limit for deputies. There has been a gradual increase until last year the maximum was raised to $3,200.00. It is not high enough but we are now asking and hope to be able to increase the maximum to $4,000.00.

However, I believe that the man who takes up regulatory work and is interested in being adapted to it receives more than the mere salary paid. He meets interesting, stimulating people in all branches of Horticulture and Floriculture and if so inclined can make close friends with the best known men in these fields.

CHAIRMAN MCLAINE: Ladies and Gentlemen: The paper that we have just listened to is one that will cause all of us, especially those engaged in regulatory work, a great deal of thought, and I am sure that it should stimulate a great deal of discussion this morning. In

addition to those who are regulatory men, we also have teachers whom I feel would like to take part in the discussion.

Mr. L. A. Strong: I rather hesitate to lead a discussion on this paper, but I think the type of man Mr. Wallace has described would perhaps fit in better with some of our regulatory work than some of the men who have been engaged in such work. Regulatory work in this country is comparatively new, and must be so recognized.

The statement that a man on a particular piece of work is too good a man for regulatory activities is one with which I can't sympathize because, to me, regulatory work is of extreme importance. It may be that a man finds himself at some particular time on a particular piece of work which is not overtaxing his capacity, and he may be capable of doing a better piece of work than he is doing at that particular moment. If so, there is no difficulty at all in finding a place in regulatory work where all of his abilities may be used.

I want to say if we can find the type of men Mr. Wallace has described, I will undertake to see to it that they are placed in positions where they will have a full opportunity to exercise all of their ability. I think Mr. Wallace has opened up a field for discussion here which is well worth the consideration of this audience and of all people who are interested in regulatory work, and I sincerely hope there will be a good deal of discussion on it.

Mr. C. H. Hadley: While listening to Mr. Wallace's discussion of his ideal regulatory man, I was running over in my mind at the same time those men whom I have considered to be pretty good regulatory men and I am rather pleased to discover that most of the men I was thinking of at the time meet Mr. Wallace's general specifications.

There is one requirement I think I would perhaps emphasize a little more than Mr. Wallace has, and that is decided interest in that field of work on the part of the man in question. I have heard the same statement as Mr. Wallace referred to, that such-and-such a man is altogether too good a man to waste on patrol work and quarantine work. In some cases I admit that I would agree with the speaker, except that I wouldn't say "too good a man to waste," but I sometimes think it is unfortunate to saddle such a man on regulatory work;—not that the man was not a good man in many respects but that he didn't have primary interest in regulatory work.

Dr. G. M. Bentley: The remarks very tersely made by Mr. Strong I thought covered the subject very well.

There were one or two things in Mr. Wallace's address. He mentioned six hours of floriculture. It seems to me if we are going to specify the different subjects, I think the subject of apiculture should be included for training in the classroom. I also think bacteriology in connection with apiary inspection is a very important one. I think the other things are all right, perhaps. I was greatly impressed by that three hours of public speaking. That is very important.

I will say in regard to the agricultural work, especially training in horticulture, and things like that, that courses along such lines are extremely important it seems to me for these men. From the little experience I have had, we strongly emphasize that, and we will not let any man go in the field who has not had a good fundamental training in agriculture.

The matter of contact and approach, I think, is important and cannot be emphasized too greatly. Many of these troubles that we hear about as we attend nursery and horticultural conventions emanate from lack of contact and lack of approach of these men in the quarantine service.

Mr. A. C. Fleury: There is one point I am not sure has been stressed that occurred to me as an exceedingly important acquisition for a satisfactory quarantine enforcement officer, and that is temperament. I believe a man has to be temperamentally fit or he is not going to make a satisfactory quarantine man, and that is something that probably he cannot secure through schooling.

The last gentleman who spoke mentioned approach, and I quite agree with him. I believe in the majority of instances objection to compliance with quarantine requirements on the part of individuals can largely be offset through a satisfactory approach. The quarantine man has to be a good salesman. He has to sell his idea to the party that he is doing business with. He is not dealing with a criminal; he is dealing with the average good citizen who may be unknowingly or unwittingly doing something that is not for the good of agriculture and which may be contrary to some law. That man must be approached not as a criminal but as a good citizen, and he must be sold to the idea of quarantine.

Chairman McLaine: Thank you, Mr. Fleury. We have with us one who has felt the effects of quarantine, and who has also been engaged in quarantine enforcement in connection with this serious and great menace in Florida, the Mediterranean fruit fly. I am going to ask Mr. Hume if he will be kind enough to say something as to the reaction of the public in regard to quarantine because he has had experience on both sides. Mr. Hume of Florida.

Mr. Hume: I must very thoroughly agree with the last speaker. The question of temperament enters very largely into the success of any quarantine regulatory measures. The man who goes out on the firing line of regulatory work must, in the first place, have absolute control of himself. Some of us are prone to resent the statement that may be made. The man who is on the front line has to take everything that comes, and take it with a smile. If he can't hold his temper and hold himself absolutely under control that is no place for him.

There is another human element that enters into it, an element in life that has bothered me very much all the way through, and that is the determination to get the other man's viewpoint because you cannot deal with him unless you can see the thing from his angle, and that is an extremely difficult thing to do.

In any manner of regulatory work, we can go no further than the people will go with us. The distance they will go with us is determined by the knowledge they have of the situation, the necessity for it, and their understanding of it. The man who approaches the individual on a quarantine line is the one who may establish that individual's attitude toward the whole work. How far reaching that person's attitude may be to the whole work, nobody can determine. You do not know who you are dealing with. You do not know how far reaching their influence may be, and whether king or pauper they must all be treated alike, courteously, firmly, knowingly.

Those are the things which, to my mind, have more to do with the proper handling of regulatory work than almost anything else; knowledge, yes, but it is the human side of it you have to give attention to.

Chairman McLaine: Before we close the discussion, the members may be interested to know that Canada has taken an interest in regulatory work for a number of years, and that her Act in regard to the important pests and diseases was based on the Plant Quarantine Act of the United States. I am going to ask Mr. Gibson, the Dominion entomologist, to say a few words.

Mr. Arthur Gibson: I think what Mr. Hume has stated, that the human side enters very much into the importance of the quarantine outfit. Mr. McLaine can speak on this better than I can. He is the man in our service who has charge of our quarantine regulations.

Mr. F. E. Whitehead: I certainly agree with the speaker that it would be very desirable to give all the work that was suggested, and I am going to raise a question rather than try to answer it. If, at the beginning of the freshman year, a student had definitely decided to go

into regulatory work I think it would work out very nicely. While I did not count the hours, I think if the student was given everything suggested this work would be required from start to finish.

In the two or three schools I have been connected with, they have made an attempt to get away from requiring so much work. They give a student a chance to elect a considerable amount.

While this other is desirable, I don't see the possibility of it. If anyone has any suggestion as to how to give all this work and still not give required work from beginning to finish, or how you could select the students or whether it is possible to get men to elect this from the very beginning, I should like to have it. I didn't become interested in entomology until I reached my senior year. It would take four additional years after my senior year to prepare for this work. I wonder if anybody has any suggestions as to how to get around this difficulty.

Mr. Frank N. Wallace: May I say that I got interested in this idea of getting men in the colleges to take it up because in regulatory work we were particularly interested in the men that came from one institution. They were all good men. They meet the public. They were interested in their work and we wondered why those men all happened to come from one institution. We found out afterwards that it was due to one man's efforts in picking those men.

I believe a man like that could pick out a man; I believe he could find them in the first year they entered college and decide they would be ideal regulatory men. I would hate to see a man decide himself that he would be a regulatory man, take four years of it, come out and be an absolute failure at it because there are some things he cannot acquire. I don't believe if he worked conscientiously all his life he could ever be a regulatory man if he didn't have some fundamental requirements. Certainly, we wouldn't want all the colleges to start turning out regulatory men, but let a few of them see if they can turn them out.

I know the positions will be open for them, but there was a time when the positions were not secure. I think that day is past. I think in most states we can definitely state that if a good man is in that position he can stay there. The heads of departments sometimes change, but a good man can stay right through.

Chairman McLaine: If there is no further discussion, I will turn the chair over to Mr. Wallace.

CHAIRMAN WALLACE: Next on the program is "Problems in Japanese Beetle Research," by L. B. Smith.

THE JAPANESE BEETLE IN 1929[1]

By LOREN B. SMITH, *Principal Entomologist, Division of Deciduous Fruit Insect Investigations, Bureau of Entomology, United States Department of Agriculture*

ABSTRACT

A summary of the present distribution, the feeding habits and injuries, life history, control measures and the results of parasite introductions.

Twelve years ago the first investigations were undertaken on the Japanese beetle (*Popillia japonica* Newman) and methods for its control. The purpose of this paper is to consider briefly the results which have accrued from this work as well as the present status of the insect.

The problems concerned with the control of the Japanese beetle are legion since it attacks a wide variety of plants and thereby affects not only the agriculturist and horticulturist but also the suburban dweller. Thus far the insect has been primarily a pest of fruits and ornamental plants, although during recent years it has shown a tendency to damage certain of our staple crops. The damage to crops has been serious only when the beetles have become very numerous. The injuries to economic plants have been local in occurrence even to the individual plants which are attacked, owing largely to the gregarious habits of the adult beetles. Hence there appears to be a great diversity of opinion among the growers and others in the generally infested area as to the economic status of the insect. There is no question that articles appearing in the metropolitan press concerning the damage by the Japanese beetle have led to great misconceptions in the minds of many as to its seriousness as a pest. It is true, nevertheless, that the Japanese beetle is an added burden to any community which offers favorable conditions for its development.

DISTRIBUTION OF THE JAPANESE BEETLE. The district of general infestation of the Japanese beetle now occupies an area 80 miles in diameter and approximately 5,000 square miles in extent in central New Jersey, Eastern Pennsylvania, and northern Delaware. The annual increase in the size of this area has been relatively slow and

[1]Contribution No. 72. Research Laboratories, United States Bureau of Entomology, Moorestown, New Jersey.

The writer wishes to acknowledge the contributions of the various investigators who have worked on this problem. Their untiring efforts in the face of many handicaps and the difficulties of the problems can be realized only by those closely associated with the work.

represents the natural spread of the insect. All infestations occurring beyond this represent colonies which have probably become established through the dissemination of the insect by some artificial means such as trains or motor vehicles. Its advance in a northward direction has apparently been retarded by the elevated hilly country in northern New Jersey. The beetle has extended its range northward to Washington crossing in New Jersey. It is still scarce along the New Jersey coast, although it has become well established in the pine-barren district in the central part of the state. West of the Delaware River the beetle has progressed with remarkable slowness. The extension of its range appears to be hampered by the presence of high ridges. In the valleys it has become exceedingly abundant, and in the suburban areas surrounding Philadelphia has caused severe damage to ornamental plants and shade trees.

The regions of densest infestation no longer coincide with the earliest infested area between Riverton and Moorestown, New Jersey. The density has moved outward, and there is a general reduction in the degree of infestation in the central part of the area.

Surveys of both the adults and larvae during the past several years indicate that the species is decreasing in the older infested area and is increasing rapidly in the more recently invaded territory.

Habits of Feeding and Injuries. The Japanese beetle is most conspicuous and injurious in the adult stage by reason of its active habits and the damage done to the foliage, flowers, and fruit of its food plants. The injury to foliage is comparable in appearance to the work of our native leaf chafers. The leaves are skeletonized and, when severely eaten, turn brown and drop, thus bringing about defoliation. Since the beetles prefer to feed on foliage exposed to the direct rays of the sun, it is not usual for them to defoliate entirely the larger trees and shrubs. The early ripening varieties of fruits are most subject to attack, and the beetles are fond of the green silk and developing ears of corn. They cluster on the tip of an ear, cut the silk off close to the husk, and feed on the developing kernels at the tip of the ear.

Nearly 300 species of plants have been recorded in the United States as furnishing food for the Japanese beetle. Among these are many of the economic crops grown in the infested territory. Between 25 and 30 species, however, are much preferred as food plants. The more important of these are apple, quince, peach, cherry, plum, grape, blackberry, clover, soy bean, and corn. The shade trees in the list of preferred food plants include linden, birch, white oak, elm, horse-chestnut,

willow, and sassafras, in addition to many shrubs and herbaceous ornamental plants. The most severe damage by the Japanese beetle now occurs in the Philadelphia suburbs, in Trenton and vicinity, and in Camden and Gloucester Counties, New Jersey.

The Japanese beetle larvae have thus far confined their damage mostly to lawns and golf courses. The injuries to the sod are comparable to those caused by the larvae of the small native May beetles of the genus *Ochrosidia*. As would be expected, the turf injury is much more severe and pronounced during periods of drought than it is when there is sufficient moisture in the soil to maintain the grass even when many of the roots have been destroyed by the grubs.

LIFE HISTORY OF THE INSECT. The Japanese beetle has one generation a year. The adults begin to emerge between the 10th and 15th of June and are present until the middle of October. The adult female beetles each lay between 40 and 50 eggs in the soil. These are deposited separately, three to five at a time, about 2 to 4 inches below the surface of the soil. The egg-laying period is usually four or five weeks in length. The larvae become full grown in about six weeks, at which time they reach a length of approximately 1 inch, and resemble the larvae of *Phyllophaga* in appearance. They usually feed about 1 or 2 inches below the surface, but as the soil temperature approaches 50 degrees Fahrenheit in the Autumn they descend to an average depth of approximately 7 inches and there they pass the winter. In the spring they again become active and, approaching the surface, feed for about a month or six weeks before transforming to pupae. The adults begin to appear between two and four weeks after pupation.

CONTROL OF THE ADULT BEETLE. When the Japanese beetle first became numerous in New Jersey, attempts were made to protect fruit by the use of a spray consisting of 1½ pounds of powdered lead arsenate to 50 gallons of water. This proved to be inadequate to protect the plants. It was later found that by increasing the dosage of lead arsenate to 3 pounds, and adding 2 pounds of flour having a high gluten content, to each 50 gallons of water, much better results were obtained in the protection of apples. This spray could not be used on peaches without danger to the plants. It was found that lime, chalk, lead arsenate, and other white materials applied to the ripening fruits repelled the beetles for a short time, although the repellent effect of all the substances except lead arsenate disappeared within a short time. As yet no effective means of protecting raspberries, blackberries, early ripening peaches, and the blossoms of flowering plants has been devised,

since the beetles tend to avoid the sprayed foliage and cluster on a ripe fruit or on an opening flower bud.

During the course of the early experiments it was believed that the size of the particles of lead arsenate might determine the quantity of poison consumed by the beetles. A colloidal lead arsenate was prepared but this gave only a slight increase in the number of beetles killed. A material known as oleate-coated lead arsenate was developed about six years ago. This is a composition of paste lead arsenate and about 2 per cent lead oleate. This coated lead arsenate has been found extremely useful in the protection of ornamental plants and nonbearing fruit trees. The lead oleate serves as an excellent sticker and spreader, and one application made in June has remained effective for the following six or seven weeks. A green lead arsenate was evolved recently which is eaten readily by the Japanese beetle. This kills a large proportion of the insects coming to the sprayed foliage, although it does not afford the protection to the plants which is obtained by the use of the oleate-coated lead arsenate.

The habit of the beetles in congregating on plants in large numbers suggested that contact sprays would be useful as a means of control It was found that a neutral soy-bean-oil soap made a very effective contact spray. Later studies revealed that the insectidical value of a soap is directly dependent on the strength of the film formed by that particular soap, and it was finally discovered that one prepared from a coconut fatty acid had the highest toxicity of any of the common soaps. A small quantity of oleo-resin of pyrethrum is now added to the soap to increase the effectiveness of the spray. Several preparations of pyrethrum and soap are available commercially and are being used as contact sprays not only for the Japanese beetle but to some extent for the striped cucumber beetle (*Diabrotica vittata* Fabr.), the harlequin cabbage bug (*Murgantia histrionica* Hahn), and certain others which up to the prsent time have been difficult to control.

Several years ago chemotropic investigations revealed that geraniol, one of the higher alcohols, was extremely attractive to the Japanese beetle. Few, if any, other insects have been found to be attracted to any degree by this chemical and it is apparently a specific for this insect. In commerce it is commonly used as an ingredient in the cheaper perfumes. Geraniol has been utilized in several ways in the control of the beetle; these include combining it with poisoned baits, as a means of concentrating the beetles in a small area where they may be killed with contact sprays, or more often as a constituent of baits used in mechanical

traps. The Japanese beetle traps have come into wide use by residents in the suburban area around Philadelphia. In conjunction with spraying, the traps are useful in capturing large numbers of beetles. During the summer of 1929 500 traps were placed on a 15-acre estate in the heavily infested district near Roxborough, Pennsylvania. The record of collections in these traps during the period between July 9 and August 23 gives a total of 1,874½ pounds of adult beetles and represents approximately 10,000,000 individuals. Many types of beetle traps are now on the market, ranging in price from 10 cents upward. The traps have not yet become sufficiently effective to warrant their use on farms. In fact, the presence of large numbers of traps may attract many beetles which are not captured, with the result that the grub population in the soil, in the vicinity of the traps, is greatly increased over what it would have been had the traps not been used.

The combination of lead arsenate with a highly refined, cane-sugar syrup has been found useful as a spray on noneconomic plants. The beetles are strongly attracted to it and eat it readily. This preparation is probably one of the most effective lethal sprays yet devised for the Japanese beetle. On account of the tendency to injure foliage it is not recommended for use on economic plants.

CONTROL OF THE LARVAE. In our studies of the control of the larvae the problem has had to be considered from two viewpoints. The first was the treatment of soil about the roots of plants and nursery stock which contemplated the extermination of any infestation which might be present. The second was the treatment of turf on lawns and golf courses. In a paper to be presented at this session, Doctor Fleming and Mr. Baker discuss the nursery treatments.

A 70 per cent emulsion of carbon disulphide, diluted at the rate of 1 quart to 50 gallons of water and applied to the turf, allowing 3 pints to each square foot of surface, has been found an effective means of destroying any grubs within the first 2 or 3 inches of soil. This is usually applied by means of a proportioner. This machine is so constructed that it can be attached to the hydrant, and as the water flows through the hose the desired quantity of emulsion is added to the water stream, the quantity added being regulated by a simple adjustment of a needle valve.

Several years of experimental work have shown that lead arsenate thoroughly mixed with the surface layer of soil will destroy most scarabaeid larvae and will not harmfully effect the growth of the grasses commonly used in golf greens and lawns. When a lawn is being made or a

golf green prepared, lead arsenate may be broadcast at the rate of 35 pounds to each 1,000 square feet of surface. The soil is then thoroughly disked to a depth of about 3 inches, graded, and planted. This treatment has been found to remain effective for between 5 and 7 years. It is possible to treat lawns having turf with a top dressing composed of 5 pounds of lead arsenate mixed with about a bushel of screened top soil or other suitable carrier and this quantity applied to each 1,000 square feet of surface. The top dressing should be repeated once a year until three applications have been made.

Parasite Introduction. Nine years of work has resulted in the establishment of five species of parasites from the Orient in the generally infested area. The first of these to be recovered after releasement in this country is a tachinid fly (*Centeter cinerea* Aldrich) which is parasitic on the adult Japanese beetle. This was collected in 1923 following the releasement of a few individuals in 1922. This colony now occupies an area of about 85 or 90 square miles. The percentage of parasitism, however, remains very low. This parasite has also been colonized at Bridgeport, Connecticut, and Harrisburg, Pennsylvania, as well as in four locations near Philadelphia. Two dexiid flies, *Prosena siberita* Fabricius and *Dexia ventralis* Aldrich, which are parasitic on the larvae of the Japanese beetle were found to be established in 1927 from releasements made during the three previous years. Both species are effective as parasites of Popillia in Japan. Dexia has three generations in Japan but thus far only two generations have developed in the United States. Two solitary wasps, *Tiphia popilliavora* Rohwer and *Tiphia vernalis* Rohwer, have been introduced from Japan and Korea and established in the United States. *Tiphia popilliavora* was sufficiently numerous in 1927 near Riverton, New Jersey, that it was possible to collect 1,100 females for use in establishing eleven subcolonies in New Jersey and Pennsylvania. Since that year 14,500 females have been collected from the parent colony and 145 subcolonies have been established. This species is undoubtedly the most promising which thus far has been introduced and established in the eastern Pennsylvania-New Jersey district.

Other factors of natural control should not be overlooked. In the heavily infested area there is no doubt but that birds, particularly the starling and crow, blackbird or purple grackle, are among the more important factors in the natural control of this insect at the present time. Pathogenic bacteria, fungi, protozoa, and nematodes all play a part, and an important part, in preventing much more serious losses by the Japanese beetle than have occurred thus far.

CONCLUSION. The Japanese beetle, as yet, does not occur in sufficient numbers outside of a 5,000-square-mile area in central New Jersey and eastern Pennsylvania to cause any economic losses. Sporadic colonies now occur as far north as Boston, Massachusetts, and as far south as Norfolk, Virginia. Whether the economic importance of the insect under these new environmental conditions will be greater or less than it is at present is problematical. Studies of the biology, physiology, and habits of the insect indicate that the short growing season in New England, the summer droughts of the Middle West, and the relatively mild winters with little snowfall in the South may tend to inhibit the extremely rapid multiplication of the beetle. At the present time the fruit growers in the heavily infested area are successfully protecting their crops by methods which have been developed. Much yet remains to be accomplished in the matter of devising better methods for protecting early ripening varieties of peaches, small fruits, corn, and plants in flower. The present methods of control for the larvae are satisfactory and if properly applied will entirely prevent turf injury. The natural factors of control, including the importation of foreign parasites, appear to be reducing the density of infestation in the areas longest occupied by the beetle, and it appears as though the future effectiveness of these elements of control will be even greater than it is now.

CHAIRMAN WALLACE: Is there any discussion of this paper?

MR. H. G. BUTLER: What experiments have been carried out as to the value of the insecticutor electric trap?

MR. SMITH: We have tested the electric insect trap known as the insecticutor, but we found it was not sufficiently powerful to destroy.

MR. GIBSON: I should like to know more about the spread this year.

MR. SMITH: Mr. Hadley has a paper following mine covering the distribution last year.

CHAIRMAN WALLACE: Next is "Treatment of Soil to Destroy the Japanese Beetle," by W. E. Fleming. Mr. Fleming is not here, but Mr. Smith will read his paper.

TREATMENT OF SOIL TO DESTROY THE JAPANESE BEETLE[1]

By WALTER E. FLEMING, *Entomologist* and FRANCIS E. BAKER, *Assistant Entomologist, Deciduous-Fruit Insect Investigations, Bureau of Entomology, United States Department of Agriculture*

ABSTRACT

This paper summarizes briefly the different methods of treating soil to destroy the Japanese beetle, *Popillia japonica* Newman, which are now in use in commercial nurseries within the infested area.

The Japanese beetle, *Popillia japonica* Newman, a recognized agricultural pest, was probably introduced into the United States in an immature stage in soil about the roots of nursery plants. It is now dispersed over a limited area on the Atlantic seaboard and is gradually spreading naturally to adjacent uninfested territory. In order to prevent its artificial dissemination with nursery products, the shipment of plants with soil about their roots to points outside the infested area is forbidden by law unless such plants are free of all living stages of the insect. Since there are approximately 5,000 dealers in nursery stock within this infested area, many of whom are doing a national and an international business, it is important that methods for handling and treating the various types of stock be developed.

In view of the fact that the immature stages are found in the soil at all seasons of the year, experiments have been conducted continuously during the past eight years to develop practical methods for preventing and destroying infestation in the various nursery products. During the course of this work it has been found necessary to evolve methods for destroying the immature stages in potting soil, soil plots, cold frames, and greenhouse benches, as well as in the soil about the roots of established plants. This paper summarizes briefly the different procedures which are now in use in the commercial nurseries for treating and handling soil under various conditions.

TREATMENT OF POTTING SOIL. Soil which is to be used for growing potted plants can be treated by heating it with live steam or by fumigating it with carbon disulphide or naphthalene. Soil of any type can be treated, provided it is dry or moist and friable.

In applying the steam treatment, steam under 70 pounds' pressure is dispersed through the soil. The soil is heated throughout to a temperature of 130°F. and maintained at this temperature for a period of 30 minutes.

[1]Contribution No. 69 of the Japanese Beetle Laboratory, Bureau of Entomology, Moorestown, New Jersey.

Fumigation with carbon disulphide is carried on in a gas-proof box or bin, by injecting carbon disulphide, of technical grade, at the rate of 1 pound to each cubic yard of soil. Any quantity of soil may be fumigated, provided the carbon disulphide is distributed uniformly throughout the mass. One method is to treat each 18-inch layer of soil separately as the container is being filled. The first 18-inch layer is treated by injecting carbon disulphide at the rate of ½ pound, or 176 cubic centimeters, to each square yard of surface, distributing the material evenly in holes 2 inches deep and 18 inches apart. When the first layer has been treated, a second 18-inch layer may be placed in the container and treated in the same manner. This process may be repeated until the container is filled.

Another method for applying carbon disulphide is to treat the soil after the box or bin has been filled. This is done by making holes from the surface to different levels so that the material is applied in the same positions as by the first method. The liquid in this case should be poured into the deeper holes through a tube to insure that it reaches the proper level before coming in contact with the soil. The box or bin is sealed immediately after the carbon disulphide is applied, and is left undisturbed for at least 48 hours.

The effectiveness of the treatment with carbon disulphide depends to a large extent upon the temperature of the soil. The higher the temperature the more quickly the material volatilizes, the more readily the vapor diffuses through the soil, and the more easily the insect is killed. The temperature should be at least 45°F. when the treatment is applied, and it should not fall below 40°F. during the course of the treatment.

The naphthalene treatment is applied by mixing 5 pounds of flake naphthalene, free from tar, with each cubic yard of soil. The success of the treatment depends to a large extent on the thoroughness with which the flakes are dispersed throughout the soil. The treated soil is stored at a temperature of at least 50°F. and left undisturbed for at least one week.

It is desirable that fumigated soils be äerated before they are used. After potting soil has been treated by any of the preceding methods, it is necessary that it be stored and handled in such a manner as to prevent reinfestation.

Treatment of Soil in Plots, Cold Frames, and Hotbeds. Soil in plots, cold frames, and hotbeds which is used for plunging pots or heeling-in plants can be treated by fumigating with carbon disulphide,

carbon disulphide emulsion, or naphthalene, or by poisoning it with lead arsenate. Fumigation will destroy the infestation present, but will not prevent subsequent reinfestation. Poisoning with lead arsenate, on the other hand, may afford protection for more than one season.

The carbon disulphide treatment is applied to moist or dry soils by injecting the material at the rate of 6 pounds to each 100 square feet of soil surface. It is poured into holes 12 inches apart and 1 to 2 inches deep, 21 cubic centimeters of the liquid being used in each hole. The holes are filled with soil immediately after the liquid is applied and the entire treated area covered with a tarpaulin or other suitable material. The temperature of the soil 6 inches below the surface should be at least 45°F. when the treatment is applied, and it is necessary that the temperature remain above 40°F. for the subsequent 48 hours.

The carbon disulphide may also be applied in the form of a dilute emulsion. It is emulsified with a suitable material such as a castor oil soap and diluted with water so that there are 90 parts of the carbon disulphide to 100,000 parts by volume of water. Two and a half gallons of the dilute emulsion are applied to each square foot of soil surface, galvanized iron strips being sunk to a depth of 3 inches to confine the liquid to the area to be treated.

The naphthalene treatment is applied by spreading 46 pounds of flake naphthalene over 1,000 square feet of surface and cultivating until the material is thoroughly mixed with the upper 3 inches of soil. The land is then left undisturbed for at least one week before using it for plants.

The preceding fumigation treatments should be applied after the adult beetles have disappeared, except in those cases where screens or other suitable barriers prevent the adults from coming in contact with the soil. Precautions should be taken also to prevent the migration of larvae from adjacent untreated soil into the treated area. This may be accomplished by treating an additional band at least 3 feet in width or by having suitable obstructions, such as tight wooden frames or concrete walls, around the plots.

Powdered lead arsenate is applied in the same manner as naphthalene to the soil. It is used at the rate of 35 pounds to 1,000 square feet of soil surface. As this material is a stomach poison which has to be eaten by the larvae, it may take several weeks before the larvae have consumed a lethal dosage. The effectiveness of the treatment is dependent upon having the poison in the soil when the eggs are hatching and upon the thoroughness with which it is mixed with the upper 3 inches.

TREATMENT OF POTTED GREENHOUSE PLANTS. There is no method at the present time of treating potted greenhouse plants that can be applied without causing serious injury to the plants. The infestation may be removed from some varieties by washing all soil from the roots, and repotting the plants with beetle-free soil, but this procedure is not recommended for general practice. The nurseryman who desires to ship potted plants outside the known infested area should take every precaution to have both soil and plants free of infestation at the time of potting ,and to grow the plants in frames or houses so protected as to prevent the beetles from getting into the pots.

TREATMENT OF HARDY, HERBACEOUS PLANTS. The soil about the roots of hardy, herbaceous plants, which are grown in the field, can be treated during the dormant season. These plants may be divided into three groups according to the methods of treatment.

The first group of plants can be safely freed of infestation only by washing all soil from their roots. The washing may be done by directing a stream of water under slight pressure on the roots or by shaking the roots in a tub of water until all the soil is removed. Among the species which may be treated by this method are *Arenaria* spp., *Calimeris* sp., *Centaurea* spp., *Chelone* spp., *Chrysanthemum* spp., *Delphinium* spp., *Digitalis* spp., *Festuca* spp., *Gaillardia* spp., *Gypsophila* spp., *Hibiscus* spp., *Hypericum* spp., and *Valeriana* spp.

The second group of herbaceous plants can be treated successfully either by washing the soil from the roots, as in the previous group, or by immersing the roots in hot water. Among the species which may be treated by these procedures are the following: *Allium* spp., *Astilbe* spp., *Baptisia* spp., *Coreopsis* spp., *Dahlia* spp., *Filipendula* spp., *Lythrum* spp., *Pentstemon* spp., *Phlox* spp., *Polygonum* spp., *Sedum* spp., and *Thalictrum* spp.

Herbaceous plants are usually most resistant to hot-water treatment when they are dormant and most susceptible when they are growing vigorously. It is, therefore, recommended that this treatment be applied only when the plants are dormant or semidormant. In preparing the plants for treatment excess soil is removed, and the roots are pruned and large clumps divided as much as possible without causing injury. Small plants, bulbs, and root stocks may be treated in bulk in wire baskets, but large plants are usually handled individually. The roots are immersed completely in water held at a constant temperature of 112°F. After the soil about the roots is heated throughout to the temperature of the bath, the plants are kept in the water for a period of 70

minutes. The plants then should be cooled slowly to room temperature and dried before being packed for storage or shipment, or before being planted in soil.

The third group of perennial plants can be treated by washing the soil from their roots, by immersion in hot water, or by immersion in dilute carbon-disulphide emulsion. Among these varieties are *Hemerocallis* spp., *Iris* spp., *Paeonia* spp., and *Rheum* spp.

In preparing the plants for immersion in dilute carbon-disulphide emulsion, the same procedure should be followed as that used in preparing plants for treatment with hot water. The roots are immersed in a dilute emulsion, containing 60 parts of carbon disulphide to 100,000 parts of water, and held in this solution at a temperature of 70°F. for a period of 24 hours. It is necessary to maintain the temperature at approximately 70°F., because if the temperature falls below 65°F. the immature stages of the beetle may not be killed and if it rises above 75°F. the plants may be injured. The treatment is effective in killing the stages of the beetle in loose, friable masses of soil when the diameter of the mass is not greater than 6 inches. It may not be effective when the soil ball is wet, compact, or greater than 6 inches in diameter. The dilute emulsion is the least injurious to plants when they are dormant or semidormant. It is recommended, therefore, that the treatment be applied only during the dormant period. After the period of immersion is completed, the plants should be removed and handled in a manner similar to that used in handling plants treated with hot water.

Treatment of Small Fruits. The only small fruit which it has been necessary to treat is the cultivated blueberry, *Vaccinium* spp. The soil about the roots of the cultivated blueberry can be treated while dormant or semidormant by immersion in hot water and handling in the same manner as the roots of herbaceous plants.

Treatment of Deciduous Ornamental Shrubs. The soil about the roots of deciduous shrubs can be treated safely only when the plants are dormant. In this condition they can be treated by washing all soil from the roots, by dipping in dilute carbon-disulphide emulsion, using the same procedure as that employed in the treatment of herbaceous plants, and by treating with dilute carbon-disulphide emulsion in the field before digging. The varieties of shrubs which may be treated include the following: *Berberis* spp., *Buddleia* spp., *Cornus* spp., *Deutzia* spp., *Euonymus* spp., *Forsythia* spp., *Hydrangea* spp., *Ligustrum* spp., *Lonicera* spp., *Philadelphus* spp., *Spiraea* spp., and *Weigela* spp.

In applying the carbon-disulphide emulsion to a shrub in the field, the weeds and debris are removed from the surface of the soil about

the plant. The soil is then leveled. After the size of the mass of soil which is to be lifted is determined, a galvanized-iron collar, at least 6 inches greater in diameter than the proposed ball, is placed about the plant and forced to a depth of 3 inches into the soil. The soil is firmed carefully on each side of the metal collar, thus forming a basin about the base of the shrub. The dilute emulsion is then prepared. The dilution of carbon disulphide necessary depends upon the temperature of the soil. When the minimum soil temperature 6 inches below the ground is between 40° and 50°F., 90 parts of emulsified carbon disulphide are mixed with 100,000 parts of water. When the temperature is from 50° to 60°F., 75 parts to 100,000 are used, and when the temperature is from 60° to 70°F., 60 parts are used. In order to avoid serious injury to the shrubs, the concentration should not be greater than necessary. The dilute emulsion is poured into the basin about the shrub, 2.5 gallons being applied to each square foot of surface, and allowed to soak into the ground. Forty-eight hours after the solution is applied, the plant may be dug and handled according to the usual nursery practice, except that no untreated soil from outside the collar should be lifted with it. It should be dug between 2 and 5 days after treatment to prevent reinfestation.

In view of the fact that this treatment is applied in the field where temperature, moisture, texture, drainage, and other soil factors are usually beyond control, it is necessary that the treatment be limited to those conditions which are conducive to effective insecticidal action. The minimum soil temperature 6 inches below the surface should be at least 40°F. for the 48-hour period immediately after application of the emulsion. The surface of the soil about the base of the shrub should be level, and treatment should not be applied where the ground has a slope of more than 1 inch in 10 inches. The treatment should not be applied to ground having a hard-pan of clay, a rock formation, or high-water table near the surface which will inhibit the proper penetration of the solution. It also should not be applied to newly-transplanted shrubs or to artifically prepared beds where the penetration is uneven and rapid. As a general guide it has been found that a satisfactory treatment is usually made when the solution disappears from the surface uniformly in less than 5 hours and when its disappearance requires more than 10 minutes.

Treatment of Deciduous Ornamental Trees. Deciduous ornamental trees can usually be treated successfully while dormant or semi-dormant by the methods used on deciduous ornamental shrubs. In-

cluded in this class of plants are the following: *Acer*, spp., *Aesculus* spp., *Betula* spp., *Catalpa* spp., *Fagus* spp., *Magnolia* spp., *Quercus* spp., *Salix* spp., *Sorbus* spp., and *Ulmus* spp.

TREATMENT OF BROAD-LEAVED EVERGREENS. The soil about the roots of broad-leaved evergreens, which are usually dug with a soil ball, can be treated only by applying carbon-disulphide emulsion in the field before digging. This should be done in early spring or in the fall when the plants are in a semidormant condition. Included in this class of plants are *Abelia* spp., *Azalea* spp., *Buxus* spp., *Cotoneaster* spp., *Ilex* spp., *Kalmia* spp., *Pachysandra* spp., *Pyracantha* spp., and *Rhododendron* spp.

TREATMENT OF NARROW-LEAVED EVERGREENS. The procedure used in treating broad-leaved evergreens can be used in treating narrow-leaved evergreens, such as *Abies* spp., *Juniperus* spp., *Picea* spp., *Retinospora* (*Chamaecyparis*) spp., *Taxus* spp., *Thuja* spp., and *Tsuga* sp.

The treatment of the soil of the various nursery products interferes, to some extent, with the normal routine of the nursery and increases the cost of production, but it has enabled many nurserymen to maintain some of their business outside of the area known to be infested with the Japanese beetle. A large part of the experimentation to develop the various treatments was carried on under emergency conditions in co-operation with the nurserymen concerned. The treatments are not entirely satisfactory because of certain necessary requirements which are sometimes difficult to meet in the nursery, and because their application is limited to specific varieties during the dormant or semidormant season. Experimentation is still under way to develop simpler and better methods for handling the various types of nursery products, so that they can be shipped outside the infested area.

CHAIRMAN WALLACE: Are there any questions? If not, the next is by C. H. Hadley.

A SUMMARY OF QUARANTINE AND CONTROL OPERATIONS

By C. H. HADLEY, *Camden, N. J.*

(Withdrawn from publication)

CHAIRMAN WALLACE: Is there any discussion? Are there any questions you wish to ask Mr. Hadley?

We will take up "The Mediterranean Fruit Fly Eradication Campaign," and Mr. Strong and Dr. Newell are going to handle that for us. I think Mr. Strong is going to say something first.

THE MEDITERRANEAN FRUIT FLY ERADICATION CAMPAIGN

By Lee A. Strong, *Plant Quarantine and Control Administration, Washington, D. C.*

Any discussion by me at this time of the Mediterranean fruit fly situation will be under what seems to be a disadvantage. Circumstances beyond my control prevented my having any intimate contact with the fruit fly work prior to the first of this month. Lack of opportunity to investigate conditions on the ground, however, has not entirely discouraged expressions of opinion as to the work that is being conducted. Some of the most profound expressions of opinion and criticism of the Mediterranean fruit fly work reaching my desk have contained no reference to the writer having been on the ground to make an investigation, or to having had any experience with fruit fly work in any place.

I want to say that the Plant Quarantine and Control Administration has no objection whatsoever to any honest expression of opinion of the work that is being conducted on the Mediterranean fruit fly, or any other work of the Department, and any honest criticism of that work is welcome.

I do feel, however, that a work as important as this work is, dealing with a pest of the unquestioned importance of the Mediterranean fruit fly, merits a rather close investigation of all the facts before a widespread criticism is voiced.

It is significant that the people who have gone to Florida and who have investigated conditions have endorsed the work of the Plant Board of Florida and the United States Department of Agriculture. In my judgment, an investigation of conditions doesn't merely embrace considering what the fruit fly has done in other countries and reading in the newspapers that banks have failed, and attributing everything that is bad to the Mediterranean fruit fly campaign. It contemplates and should embrace an intensive investigation of all conditions in Florida, of the economic conditions in Florida, and not only what the fruit fly has contributed to the present economic condition but what other factors contributed to the economic condition which existed before the fruit fly was found in Florida.

I have had an opportunity during the past month to find out something about the fruit fly work, and I want to say that I don't believe a problem was ever attacked in this country in the same manner that the fruit fly problem has been attacked. The fruit fly represented the major problem in insect control and extermination when it was found in this country. We have heard for a number of years that the fruit fly once

found has never been eradicated. I don't know of any real, honest effort at extermination that has ever been made before.

When you consider the population of flies that was found in Florida, the district that was infested, the conditions which had to be met, the difficulties which had to be overcome in starting an eradication program on a pest of that kind, and when you consider that from the sixth of April the fly population was reduced until now there has not been a single live fly found in Florida since the twenty-seventh of August, with the exception of the orange found on the sixteenth of November infested with larvae, I will say that any criticism of the work that has been conducted is appropriate only after a full investigation of what has brought about that condition.

The attitude of the Plant Quarantine and Control Administration, the whole Department of Agriculture, the State Plant Board of Florida, and the citizens of Florida, has been that there is only one thing to be considered and that is the complete extermination of the fruit fly in the United States. Every movement that is being made is looking to that end.

Naturally that involves the cooperation of everybody who is interested in the eradication of fruit fly in this country, whether they reside in Florida or not. The condition which exists today, and I think it is a remarkable one and is a tribute to those who have been in charge of the work (and I can say that because I have had nothing to do with it at all until the first of this month), could not have been brought about if it hadn't been for the 100 per cent cooperation of the citizens of Florida. We have had objections from people down there, just as I would object or you would object if you had your crop destroyed or a part of your crop destroyed. The restrictions are burdensome, are bound to be, and for that reason because they are burdensome and because just as long as the fly exists in the United States burdensome restrictions will have to be maintained, it is unthinkable that any program could be considered but eradication—eradication and complete eradication as promptly as possible. That is the only answer to the burdensome restrictions which now exist.

We are meeting with some objection, and perfectly honest objection, on the part of some of the states outside of Florida to what they have considered has been a little bit too lenient an attitude perhaps on the part of the Department in permitting the movement of products out of Florida.

The research bureaus of the Department cooperating with the Florida people have made remarkable progress in the working out of methods for

the treatment of fruits, and in the poison baits to reduce the population of the fly.

This is my personal observation in Florida. The quarantine enforcement around the eradication area is, in my judgment, as fine a piece of quarantine work as I have ever seen. I wish Mr. Wallace could go down there and see these men picked up without any previous training in quarantine work, and who under certain methods of discipline have developed into a fine set of quarantine officers.

All those things, plus the fact that no fruit is being moved at all which is under suspicion of being infested, lead us to believe that we are taking those precautions which are adequate to prevent the spread of the fruit fly to the other states.

Now, then, we are assuming an obligation in the United States Department of Agriculture when we permit the movement outside of Florida of these fruits. We assume the responsibility for 100 per cent treatment of that fruit. We say that the treatment is effective 100 per cent in killing any Mediterranean fruit fly which may be present in every stage. We have to say that or else we are not justified in allowing that fruit to move. We have to guarantee that our supervision is 100 per cent, otherwise the states would not be justified in accepting the fruit.

I believe if the quarantine officers of the various states in which this fruit is going would go to Florida, look into conditions there, observe the packing house requirements, packing house supervision, the grove inspection which, by the way, is not built up to the point which we would like to have it and which we expect to have; if they would look over the enforcement of the quarantine at the eradication line, I believe they would feel a great deal more comfortable in accepting this fruit in their state.

We have, on the other hand, objections from the citizens of Florida who feel our restrictions are too drastic. The fact that with but one exception no fly has been found, since the twenty-seventh of August, has led to a more or less general belief among the people not fully informed that the fly has been completely exterminated. I don't believe it has. I think we are going to find more flies in Florida, but I am very hopeful that we will find them in such places and in such limited numbers that our force will be adequate to immediately stamp them out.

We have reached a point in decreasing the population of the fly where the only thing that can be thought of is eradication. We must eradicate the fly. If we let it spread to other states our task is not nearly

so easy. It is far easier if we can keep the fly confined to the present locality of known infestation and stamp it out. If we are not able in this country, after building up our quarantine restrictions over a period of years, to cope with just such a situation as this—and if after all these years of enforcing restrictions, and after all the results that have been accomplished we are going to let this fruit fly get away from us, I say it is a pretty serious indictment of the regulatory workers of this country. I believe every entomologist and every citizen believes in the work, in the protection of agriculture, and realizes the necessity for the eradication of the pest; they not only recognize this need, but will be back of it.

I am not in a position to discuss the details of the work. Dr. Newell is here. He has been on the line every minute since the fly was found in Florida, and I am going to let him say whatever is said about the details of the work. (Applause)

CHAIRMAN WALLACE: Dr. Newell. We will wait for any discussion until we have heard from both of you.

THE MEDITERRANEAN FRUIT FLY SITUATION

By WILMON NEWELL, *Gainesville, Fla.*

Mr. Chairman, Members of the Association, and Visitors: I had a very severe shock this morning when I learned that Dr. Marlatt was not going to be here to appear on the program to discuss the fruit fly situation and I was advised that I would have to substitute for him. It would be a very difficult matter at any time for any member of this Association to attempt to substitute for so able a speaker as Dr. Marlatt, who not only possesses the ability to pack a great deal of very valuable information into a very short space of time but has the ability to present it with most charming grace. We are also handicapped by the fact that we do not have the slides which Dr. Marlatt had expected to use in illustrating his talk. I must, therefore, apologize in advance for a somewhat rambling discussion of this situation, using a very hastily assembled outline in the preparation of which Dr. J. H. Montgomery assisted me this morning.

I am glad Mr. Strong has discussed some of the general features of the fruit fly situation. All he has said is pertinent to the subject, and that leaves me free to confine myself almost entirely to some of the details.

Naturally, any discussion of this situation—which has developed since our last meeting—would open with a statement that the fruit fly,

for the first time in the history of North America, was discovered in this country on April 6, the point of discovery being Orlando, Florida, in the very central portion of the State and in the very heart of the great citrus and winter vegetable industries.

On April 9, C. T. Greene, of the United States National Museum, examining specimens in Washington sent from Orlando, identified them as the larvae of the Mediterranean fruit fly. The following day, April 10, adult specimens, captured in groves in Florida, were identified by C. T. Greene and J. M. Aldrich of the United States National Museum as *Ceratitis capitata* Wied., thus confirming the larval determination very quickly, and leaving absolutely no question as to the identity of the insect.

Between April 6 and 9, while specimens were enroute to Washington and in process of being examined, five trained inspectors were at Orlando attempting to delimit the infestation and determine its intensity. By the 10th, thirty more inspectors, formerly employed or in the employ at that time of the Plant Board of Florida, on other work, were on their way to Orlando. Immediately after this discovery Dr. C. L. Marlatt, accompanied by Dr. A. C. Baker, the head of the Tropical and Sub-Tropical Insect Investigations of the Bureau of Entomology, proceeded to Florida.

Most of you probably know that the Bureau of Entomology has maintained at Orlando for a number of years a well-equipped laboratory for the study of citrus insects and diseases. The services of this laboratory were, of course, immediately available with a considerable number of its regular force.

On April 15, nine days after the discovery of the fly, the State Plant Board met and promulgated quarantine regulations covering intra state movement of dangerous material. That State quarantine indirectly had the effect of shutting off the flow of dangerous material to other States some time in advance of its being possible for the federal Department to get its quarantine machinery in operation.

You probably know that in recent years there has developed from Florida into adjacent States a very large movement of citrus fruits by truck, called "bulk movement." Truckloads of fruit, usually of inferior grade, not packed in boxes, but loaded just as one would wheat, potatoes, or turnips, were transported over good roads to all parts of the South for retail sale. The State quarantine measures, placed in effect very quickly after the discovery of the fly, stopped that movement entirely. Very fine cooperation was secured from all of the local police officials.

County traffic officers, city police forces and others responded quickly to the appeal of the Plant Board to assist in enforcing that quarantine. Where there had been many hundreds of truck loads of fruit from the infested area moving to other States, this movement was cut down to practically none at all within a very few days.

At the same time, the Plant Board appealed to the Governor for permission to make use of the National Guard of Florida for enforcing the quarantine, and it was during the few days' interval between this request and the authorization on April 17 for calling out the National Guard that the local police officers and county officers did such excellent work. The action of the Board, of course, was to throw a quarantine around the area in which the fruit fly had been found, and that line was quickly manned by members of the Florida National Guard in uniform, acting as agents of the Plant Board. Shortly afterwards a special act of the Florida legislature was passed, authorizing use of the National Guard for the enforcement of the fruit fly quarantine. Of course, the members of the National Guard were as readily instructed in matters of enforcing quarantines and intercepting dangerous material as would be any other body of men similarly employed, and the fact that it was an organized body of men already under discipline made it possible to get the quarantine into effect very quickly.

On April 15, through joint action of the Governor and the State Plant Board, a $50,000 emergency fund was released from the State Treasury. On April 17, the Department in Washington made available $40,000 by transfer from the pink bollworm appropriation. By Public Resolution No. 1, 71st Congress, approved May 2, 1929, there was made available for combating the fruit fly $4,250,000 from an appropriation previously made for other purposes but which had not been expended.

On April 10, the Department transferred to Florida six trained fruit fly inspectors from the Rio Grande Valley where they had been engaged in work against the Mexican fruit worm. Ten pink bollworm scouts were, on April 12, transferred from Texas to Florida.

At the same time, the entire organization of the State Plant Board, numbering some sixty men, quite a large number of the Experiment Station staff and a number of extension workers, were drafted, so that very shortly there was an organization of upwards of 150 men at work.

As I have said before, the laboratories of the Bureau of Entomology and the Bureau of Plant Industry also had a number of men available. The Bureau also had two or three trained entomologists at its Sanford laboratory just a few miles north of Orlando, and they were made available also.

There followed immediately the recruiting of a force to deal with the situation, this, in a large measure, embracing past employees of the Department or the Florida Plant Board, men who had previously been engaged in citrus canker eradication or inspection work, or in certain lines of work which previously had been carried on by the Administration or the Bureau of Entomology. We have members on this Florida staff who have worked on the corn borer, Japanese beetle and gipsy moth projects, a pretty representative collection of men who have had experience in Federal and State activities of this character.

On April 28, the Plant Quarantine and Control Administration held its hearing in Washington on the question of placing a quarantine upon Florida and Florida host products. As a result, Quarantine No. 68, and the Rules and Regulations Supplemental Thereto, were promulgated, effective May 1. The work of the Plant Quarantine and Control Administration was quite readily divided into what might be termed three major projects in connection with the fruit fly campaign; first, "cleanup, quarantine enforcement and identification work in Florida;" second, "research work" conducted by the Administration in cooperation with the Bureaus of Entomology, Plant Industry, and Chemistry and Soils of the Department, and the Florida Experiment Station. Dr. A. C. Baker was placed in charge of this work and immediately took up his activities very vigorously at Orlando.

Another project, "Activities in the Southern and Western States," was placed in charge of P. A. Hoidale who had been for a considerable period in charge of the Mexican fruit fly work in the Rio Grande Valley.

I will not take time to discuss the quarantines in any detail. It is only necessary to tell you that the quarantines of the Plant Quarantine and Control Administration, Department of Agriculture, apply to interstate movements, whereas the quarantines promulgated by the State of Florida apply to intrastate movements and the enforcement of such regulations and measures within the State as are deemed necessary for the eradication and the carrying out of the purposes of the Federal regulations. The two, of course, parallel each other.

The interstate quarantines may be illustrated by the manner in which citrus fruits are permitted at this time to move interstate from the eradication area, and indeed from almost the entire State of Florida. Quarantine No. 68 naturally applies to the whole State as being the State in which infestation occurs, but the restrictions applied in the area where no infestation has been found are not quite as drastic and exacting as those applying to products produced within the area in which infestation has been found.

In the case of citrus fruits (such as oranges or grapefruit), shipped at the present time from any point in the eradication area, the groves or orchards are inspected to see whether there is any indication of fruit fly being present. In addition, the owner of the grove is required to pick up at weekly intervals all dropped fruit and windfalls and make safe disposition of them. Safe disposition in this case consists in burying them with lime and covering with not less than three feet of earth. In addition to that, he has been required to spray his grove with bait spray a number of times, usually three or four.

A permit is issued for the movement of the fruit from the grove to the fruit packing house. At the packing house, an inspector checks in every box of fruit, and verifies the fact that it has come from an inspected and certified grove. The packing house inspector also keeps track of the identity of all fruit arriving at that house to see that it goes only to destinations approved under the regulations. If the particular lot of fruit is to go to a part of the United States where sterilization is required, sterilization is performed by the management of the packing house checked by a representative of the Department. As a rule, temperature readings are made every three hours, or oftener where automatic recording devices are not installed, and the sterilizing inspector stays with the lot of fruit from the time it goes into the sterilizing chamber until it comes out, and must verify the maintenance of its identity until it is loaded into the car and billed out.

Following the checking of the sterilization in the packing house, permits are issued for the shipment of every carload of fruit, the inspector seeing that it goes to a permissible destination. The transit inspectors of the Department check these cars at the diversion points and again at destination. The fruit is watched from the time it is picked off the tree in the grove until it is finally delivered to the retail merchant.

The activities within the State under the State quarantine consist, of course, in preventing the movement of material from the eradication area to the rest of the State of Florida except under permit and proper safeguards.

I regret we have not at hand a large map of the State but from this small one, you will note that the eradication area is bounded on the south by a line passing through the southern edges of Polk and Osceola counties, on the east by the Atlantic Ocean, on the north by an irregular line beginning a little south of Jacksonville and extending across the State to the Gulf at or near Cedar Keys, and on the west by the Gulf of Mexico. You will readily see that spread overland cannot take place east or west, but only north and south.

In the area which I have tried to indicate and which is called the eradication area, there have been recorded 1,000 infested properties. That number, of course, includes city properties, and small back yards, as well as commercial plantings. These 1,000 infested properties were distributed through twenty counties. That area contains 10,000,000 acres, or between 15,000 and 16,000 square miles. In it is located 72 per cent of the bearing citrus trees of the State—orange and grapefruit—producing normally (6-year average) 73 per cent of the State's citrus crop. The citrus acreage in the area is about 120,000 acres, and of non-citrus host fruits and vegetables there are about 160,000 acres.

Fortunately, conditions of soil, terrain and topography in that section of Florida lend themselves to the enforcement of quarantines of this character. Because of sandy land in some places, swamps and dense hammocks in other parts, it was necessary to build the main highways following certain characters of the topography. Therefore, we do not have to contend with the possibility of prohibited or contraband material being hauled across the country anywhere and everywhere. If it is to be transported, it must follow the highways. Therefore, we have had a very great natural advantage in examining the traffic moving out of that area.

Up to December 31, 1929, on the northern and southern boundaries of the eradication area, 2,670,994 road vehicles had been inspected, of which 28,850 were found to contain host fruits or vegetables which were confiscated. In those vehicles there were 1,773,446 pieces of baggage which were also inspected. The inspection has been courteously but thoroughly done.

Another precaution made use of in that area which, so far as I know, has not been used to any extent elsewhere in eradication work, is a screening requirement. All railway coaches and cars operating in that area or passing from it to the other parts of the State are required to have screened windows, and either screened or closed doors.

All trucks and vehicles transporting host fruits and vegetables within the area, such as the trucks sent out by commission houses to deliver fruits and vegetables to small towns, and delivery wagons of local merchants used in handling fruits and vegetables, are required to be screened. All host fruits and vegetables placed on display in stores or elsewhere for any purpose must also be kept screened.

The infestation, as I stated, was found at Orlando in the central portion of the peninsula, and within a few miles in every direction from Orlando nearly every property was infested. It was very interesting to note that these infestations radiated out along the highways from

Orlando, which was apparently the original point of establishment. As the distance from Orlando increased, the infestations became more and more scattering. Also, as a rule, they became much lighter. In fact, on getting away from the immediate territory around Orlando and Orange County in which Orlando is situated, there were very few infestations that were heavy.

We hold to the opinion that the fly had not been established in Florida for more than a few months before it was discovered. The work of Dr. A. C. Baker and his studies in Florida of the life history and development of the fly show that the average number of eggs laid by the female is 500. The minimum life cycle is twenty-one days. The average life cycle, under the mean Florida temperature the year around, is thirty-four days, including the pre-oviposition period.

You well know the reputation this insect has for infesting a very large number of fruits and vegetables. You already have records made in foreign countries indicating about seventy host fruits and vegetables for the fly. In Florida, research workers, under Dr. Baker's direction, found all varieties of citrus fruit subject to infestation except sour lime and the Rhangpur lime. In the open fields, peaches, plums, pears, guavas, figs, Surinam cherries, two other species of Eugenia, and maypop have all been found infested. In the laboratory, where studies have been made with the flies in cages under Dr. Baker's direction, about 110 fruits and vegetables have been found subject to infestation. By that we mean that the eggs were not only deposited in them, but the resulting larvae were able to develop and mature in those same materials.

Brief reference to the eradication measures taken and of what they essentially consist may now be made. First of all, of course, inspection is made in the attempt to find all infestations and to delimit the infested area. Essentially three types of inspection are used in the field: *scouting inspection*, which is a rather hasty inspection, was used in the early days of the campaign to quickly delimit the infested area, but is used now scarcely at all; the so-called *standard inspection*, and *intensive inspection*. We now have engaged in the field inspection work in Florida 599 inspectors. These are in addition, of course, to packing house inspectors, sterilization inspectors, permit agents, cleanup foremen, mechanics, and others.

The second important thing in the eradication program is prevention of spread. You can't eradicate anything so long as you continue to let it get into new territory. I have already discussed this feature sufficiently in connection with the quarantine measures. I did omit saying,

however, that in addition to the inspection of automobiles and trucks when they leave the eradication area, no baggage carried by rail is permitted to leave that area without inspection. Hence a plan was devised by which no baggage could be taken on trains unless first inspected for host fruits or vegetables.

Coming now to the direct measures used against the fly itself, these consisted of two principal operations,—*cleanup* and *spraying*. Cleanup refers to getting rid of all materials that were infested or likely to be infested. Equipment was not available in the beginning, but we pressed into service county and city owned trucks. We bought some, hired some, and borrowed some. But, to make a long story short, the official forces engaged in the work destroyed the equivalent of over half a million crates of citrus fruits, host vegetables, and non-citrus and minor host fruits.

The handling of all this material was greatly facilitated by the Administration sending to Florida, from Toledo, practically two train loads of equipment that had been used in corn borer work, some of which could be used immediately on its arrival in Florida, and most of the remainder was of such a character that it could be modified to suit Florida conditions.

Host material was safely disposed of by either of two principal methods. One is burial with plenty of quick lime in a pit, the floor of which has been treated with oil. After a layer of fruit has been put in the pit and limed, about six inches of dirt is placed on top of it and sprayed with oil. Then other layers of fruit and soil may be added, finishing off with at least three feet of soil on top of the last layer of fruit. This final covering of earth is also treated with oil.

The other method developed by the research workers is to grind the fruit and at the same time to sterilize it with steam. The machines developed for that purpose are able to grind and sterilize a large truck load of fruit in about eight minutes.

In addition to the material destroyed by the official forces, it is probable that even more material was gathered by the volunteer citizens' organizations, and by the growers and farmers themselves. Appeal was made to every property owner throughout central Florida to get rid of everything on his place that might possibly serve as material in which the fruit fly could breed, and the response was marvelous. I have never seen anything like it in time of peace, and I don't know whether I ever saw anything like it during the World War. It seemed as though every man, woman and child in the whole area turned aside from their regular

vocations and went to work gathering fallen fruit and disposing of the vegetables in gardens. Boy Scouts, students, clerks, workmen, pitched into making a thorough cleanup of that area, and in a short time it was cleaned up.

That, of course, was one of the direct measures used in destroying whatever larvae might have been present in those fruits and vegetables, and besides breeding places for future generations were cut off.

But in addition, flies that had already matured had to be thought of, as well as those that possibly might mature from material which had escaped destruction in spite of the pains taken, so the so-called bait spray was put into use. This spray was based on the work of Mally and others. The term "bait spray" is a misnomer: fifteen inches is about the maximum distance of attraction. The contact of the fly with the sprayed surface is more or less accidental. When the fly does come in contact with it, however, the bait is readily eaten with fatal results.

The trees are not sprayed all over with this spray as one would spray for scale insects, for example; merely a spot spraying, a dash, probably a pint or half a pint into the head of a large grove tree is all the spraying required. This spray was applied not only to all commercial groves throughout the eradication area, but to vegetation around groves, and to wild vegetation along the roadways. Up to the thirtieth of November 18,554 miles of roadside were sprayed.

Power sprayers were used largely. For the smaller properties in the towns and cities, knapsack sprayers were used. During the height of the spraying season, July, August and September, our record for spraying done by the Administration's own forces ran as high as 110,000 to 120,000 acres of groves a week.

As a further step in the eradication work, it was necessary to maintain a host-free period in the eradication area, a period in which no host fruit or vegetable was permitted to reach maturity and so become a breeding place for the fly. The host-free period extended from April 1 to October 1 in the case of fruits, and for host vegetables from June 15 to October 1. In addition to that, for citrus fruits, the attempt was made to maintain a host-free period throughout the entire State of Florida from the first of April to the first of October.

You will be interested, I think, in knowing what the effort has cost so far, or rather what has been expended. To December 31, the Plant Quarantine and Control Administration has expended on eradication, inspection, identification and quarantine enforcement in Florida $3,782,-007.86 and on research $242,904.28. The State of Florida expended to the same date, $126,298.66.

A very important part of this activity, one which could not have been dispensed with, was the research work carried on under Dr. A. C. Baker's direction with the assistance of Dr. L. A. Hawkins of the Bureau of Plant Industry, Dr. Oswald Shreiner, and others from the Bureau of Chemistry and Soils. Representatives from nearly all Bureaus in the Department of Agriculture, and the Florida State Institutions also assisted in this work.

Certain things stand out as very definite accomplishments in connection with the research work: first of all, the development of more effective sprays and combinations of sprays for killing adult flies and, in the second place, the development of methods of sterilizing the fruit to guard against any residual danger of infestation.

Two methods of sterilization have been developed by Dr. Baker and put to extensive use by Dr. L. A. Hawkins. One is a cold method by which the fruit is subjected to a temperature of twenty-eight degrees Fahrenheit for five hours and held at thirty degrees for the remainder of a five-day period. The other is a heat sterilization method, by which the fruit is held eight hours at a temperature of 110 degrees F. Both of them are absolutely effective against all stages of the Mediterranean fruit fly. In the hands of intelligent, careful operators no damage is done to the fruit.

The determination of possible or potential hosts has also been a very important feature in connection with the research work.

Now we come to discuss the results of all this effort. I think that can be given best by a statement of the number of infestations since the work started the middle of April. Between the discovery of the fly on April 6 and the end of that month 364 infested properties were found. In May, 378 more infestations were found. However, before the end of May, cleanup work was well under way, and spraying with the bait spray was also well under way. In June the number of infested properties dropped to 185; in July 64 were found, and in August 8 infestations. Since the twenty-seventh of August only one infestation has been found, and that was on November 16 ten miles west of Orlando. It consisted of four larvae in one orange. There is every reason to believe that this infestation was found in its incipiency.

Of the 1,000 infested properties 999 are no longer technically called infested properties. They have been released from that classification by the Department and by the State Plant Board of Florida, and the fruit produced in them and in their immediate vicinity is handled under exactly the same precautions as the rest of the fruit is handled in the eradication area.

The appearance of this insect in North America is a challenge to economic entomologists. If you stop to think about it, economic entomologists have never done anything really big. Don't misunderstand me. I am not disparaging the wonderful taxonomic work, the biological work and the development of control measures, but the entomologists have never done anything comparable to what the engineers did when they built the Panama Canal. Entomologists have never done anything comparable to the development of a heavier-than-air flying machine, or the development of radio or wireless telegraphy. We, as a group, have never done anything comparable to the eradication of yellow fever from the Southern States in 1905, a job which was essentially an entomological one but which was done by physicians instead of entomologists. As entomologists, we have never done anything that compares with the eradication of the cattle tick from the South, another job that is essentially entomological but instead of entomologists doing it, it is being done by animal industrialists.

We have seen one pest after another secure a foothold in this country in the last forty years, and despite our efforts they have stayed. The time has come, my friends, to do something in applied entomology that will compare with what men in other professions are doing in this day of progress. The more should we do it because we know that the greatest battle man has confronting him is against insects, and we are the men who have been designated and called upon, and are pointed out as the experts to deal with these problems.

If you will stop to think about it, there is no reason or common sense why a foreign pest should be permitted to find lodgment in this country and continue to stay here in spite of entomologists, agriculturists, and everybody else, and forever afterwards take a tremendous toll not only from the producer but from the consumer as well.

As Mr. Strong said to you this morning, the outcome of this effort to eradicate what is acknowledged to be the major fruit pest of the world is going to have a very profound effect on the thought of the public and upon the position of our profession in the next few years. If this undertaking fails, there will probably be no more appropriations by Congress or States for undertaking the eradication of anything, at least for a quarter of a century. On the other hand, if this campaign succeeds it will be a wonderful precedent; it will demonstrate that there is something to economic entomology. If this fly is eradicated now, or in the near future, within twenty-five years intelligent people of this country will wonder why we were such fools as to let a foreign pest invade our shores and have its own way.

It is an opportunity because the progress made in the fight against this thing is almost beyond belief. We admit that what has been done is impossible to do, but it has been done so far as human examination, investigation and inspection can determine. There has not been one development of any kind in the history of the work since April 6 to make any intelligent entomologist believe that the Mediterranean fruit fly cannot be eradicated—not a thing.

Of course, the opportunity that exists now is not going to last. The Mediterranean fruit fly breeds while you go home to dinner and while you are asleep at night. It breeds on Sundays and holidays, and it keeps on breeding while Congress is deciding to make an appropriation. You have to keep up with the fly and keep ahead of it if it is ever to be exterminated. The situation is a critical one. In spite of the insect having been reduced from millions to the point where one only infested orange was found in four months—and that of itself is almost unbelievable—there are people in Florida and in other States writing to Congress opposing the appropriation of any more money with which to complete the eradication.

What more could you ask for than a record such as has been made, as a basis upon which to give further moral and financial support to such an undertaking? You couldn't have any better record than has been made!

I want to say to you now that this is the greatest opportunity with which the entomologists of America have ever been confronted, the opportunity to put their moral backing and to put their backing as men of professional prestige behind Congress, and give the Department of Agriculture the opportunity to finish the job. (Applause)

CHAIRMAN WALLACE: It is now one o'clock. I doubt if we should start any discussion of these papers until after lunch. Is that all right? We will adjourn to meet promptly at two o'clock and take up the Mediterranean fruit fly.

Monday Afternoon Session, December 30, 1929

CHAIRMAN WALLACE: I should like at this time to call on Mr. H. W. Hume, to say a few words to us about the Mediterranean fruit fly before we open up the matter for discussion from the floor.

MR. H. W. HUME: Mr. Chairman and Gentlemen: I suppose that of all the insects that have come to American shores, the Mediterranean fruit fly was the best advertised. It had left a mean streak of history behind it over a period of a century or more, and it was rather problem-

atical as to what it would do or what it might not do under American or under Florida conditions. So thoroughly had it been studied in other lands, and so thoroughly had its work been known, that I have the feeling that even among you—and I am speaking as one apart because I am not an entomologist—there was a feeling of skepticism as to what might be the outcome, and I think perhaps that on the part of some of you there was also a feeling that the undertaking was doomed to failure. I have reason to know that there still is a feeling in some quarters that the situation as it appears to have developed has an unreality about it. But the situation as we have gone through with it has been a very real one. It might be well to remember that over a period of a very few months there has been put into that fight more of men and more of money than has ever been put into any similar undertaking in the same length of time. We ourselves at the other end of the line had thought we might stand in the position in which we find ourselves today at the end of two or three years' time, and I think I may as well say to you that the surprise has been very great to us as it has perhaps been to many of you. I want to point to this fact also in the same connection, that there have been entomologists in Florida from time to time since this outbreak. I think they have had this same feeling of skepticism as to what the situation really was, of what the possibilities of it were, and yet I do not believe that any one of them has come away from the state after looking the situation over with a feeling other than that the work was being carried through to a finality. Exactly where we stand on it, of course we do not know. We cannot know for some months to come, but there appear to be no questions in the mind of anyone who has looked into it but that the situation has been squarely met and that it can be carried through to a final conclusion.

Now there has been criticism in quarters in Florida, for instance, of things that have been done. I do not believe it is possible to carry through any campaign such as we have been through without making some mistakes, and I think those who are closest to the work should sit down now, perhaps, and review the situation and point out things that were done that need not have been done, and yet I will defy anybody to place his finger on a mistake that has been made that has not been made on the right side of the problem.

Is this to be left as it stands, as an unfinished job? Those situations have developed in America before, where an insect was in hand and then got out of bounds and beyond all chance of coping with it on the basis upon which we are undertaking it. Shall we go on and finish it or

shall we stop? The last is unthinkable! We have put into it much of time, much of hard work, much of money. If we stop, that all goes into the discard. As Dr. Newell pointed out this morning, the campaign we are waging in Florida means more to economic entomology than anything that has come before it possibly at any other time. As I said a while ago, here we are meeting a foe that was the best advertised one that ever came to America. Many of those who have come in were practically unknown before they reached our shores. Such certainly was not the case here.

I beg of you in every direction for your support, for your kindly feeling toward the work which is being done. (Applause)

CHAIRMAN WALLACE: Certainly some of you want to ask some questions. The whole situation is open for discussion. Is Dr. Dean here? I should certainly like to hear from him. Dr. Dean, I certainly would like to hear you say a few words if you will about the Mediterranean fruit fly.

MR. G. A. DEAN: I have had a great deal of interest in the remarks that have been made this forenoon and this afternoon in regard to the Mediterranean fruit fly.

I have been surprised at some of the rumors that have come from Florida since a group of us were down there. I was somewhat surprised at some of the rumors that were abroad at the time we went down. I am referring now to the special commission that was appointed by Secretary Hyde to visit Florida, go over the work, visit the orchards, consult with the various business organizations, members of the legislature, growers, small and large, or any other organization in Florida. Of course rumors do start. You must expect that. They always will. Yet I am surprised that some will even think or bring themselves to the place where they might think some of these had some truth in them. I don't want to talk on that. I will simply dismiss it.

Not very long had I returned from Florida when a group of two or three entomologists came to me and said, "Dean, I want the lowdown on the report of this committee."

I asked, "What do you mean by the lowdown?"

"I would like to know whether that report of that special committee endorses the work that has been done, and the work that has already been published to such a place that it is believed it offers an excellent opportunity for eradication, and that the eradication program should be continued by all means."

That was a unanimous report; there is no question about it. There wasn't a person on that committee who went to Florida who did not believe they had just about as well have given their report before they went to Florida, and that to talk eradication of this insect that had already become established was ridiculous. It was unbelievable. There were on that committee some men who had been in big projects, men who could think and analyze situations. I mean outside of entomologists, not saying that there were not some entomologists on there too who had been in some fairly large undertakings. But it was an unanimous report, and it is just as Dr. Hume said a few moments ago. I believe that anyone who will go to Florida and go over the work, see what has been done, analyze it, will be greatly surprised. He can't help believing that things have been done that seemed impossible. Many things that were apparently impossible, have already been done. As I said before, that was a unanimous report of the committee.

We believe that the work even at that time was such that eradication was possible. Many rumors were out when we went down there of the insect living in the great swamps of Florida and everything of that sort, and that there was so much wild fruit that might be infested which it would be impossible to eradicate. How much of it has been found in the wilds? Dr. Hume can tell you, Dr. Newell can tell you how much of it has been found out in the wild fruit. In the last four months, with the exception of one place that Dr. Newell mentioned, nothing had been found anywhere. The survey has been made over what he called the wild lands of Florida, out where the wild fruits have been growing, which may have been cultivated. Dr. Hume found a single infestation in the wild fruits.

Mr. Hume: Of the native wild fruits, one has been found infested.

Mr. Dean: That gives you some idea. When we went down there, what was out in the wilds was not the problem at all. The most serious thing as I see it at the present time is that there are groups who are letting themselves believe that things exist in Florida that do not exist at all; that people have faith in or believe the rumors that they are hearing. Of course I will say, too, coming from some of the sources that they have come from, it explains to a certain extent why some people would want to believe them. The thing I want to impress upon you if I can is for you, before you criticize the committees that have been down there, two of them, or before you criticize any of the work and say it cannot be done because it has not been done, to just withhold your criticism at least in broadcasting it until you have had an opportunity to really

look into what has been accomplished in Florida and see the situation as it actually exists. I feel just as Dr. Newell did, if there was ever an opportunity offered to us up to the present time to attempt eradication with wholeheartedness, this is it. Now, since almost unbelievable results have been accomplished, it seems to me that we certainly should lend every effort we have to push the thing to finality, as Dr. Hume has stated.

I don't believe you have heard me talk very much on eradication. There is only one time I ever did and that was about the European corn borer, and I haven't changed my mind very much about that since it started. The eradication of the European corn borer, even if only in Boston or the vicinity of Boston, is a problem entirely different from this one. If we had the time I could name thirty-five or forty reasons why this insect might be eradicated where the European corn borer could not. We haven't time to go over them, but there are some things to be considered if you take the time to analyze them and see what it has really offered toward eradication. I, for one, believe it can be done, and I want to lend my support in any way I can in helping the work. (Applause)

MR. H. H. KIMBALL: There is one phase of this Mediterranean fruit fly work that in my opinion has not been presented to you as fully as it might be, and I am going to take the liberty of saying a few words about it at this time. There always is bound to arise the question of those of us who are interested in the control or eradication of insect pests as to the possibility of that pest having spread outside, way outside, through commercial jumps, of the area that is known to be infested, the area in which the intensive work is going on. It is about that particular phase of it that I should like to say just a few words.

I had the privilege of attending the meeting that Dr. Newell referred to, in Florida, the first meeting that was held in Florida, the original meeting of the Plant Board when the first quarantine was promulgated. So far as I am concerned personally, so far as we are concerned in organization in Mississippi, we have been directly behind the work and intend to stay directly behind it in any way we possibly can.

Immediately after funds became available, a certain amount was allocated to each of the states that had been most seriously exposed, we might say, to infestation. In Mississippi, during the months of June, July and August, we had about seventy-five men in the field scouting the state, looking in wild and cultivated fruits. We have a subtropical section down in the southern part of the state, and we were naturally

concerned very much on that account so far as it affected all of our fruits. So we pitched into it and by the selection of danger centers, which we were pleased to term them, we intensified our work around those sections and made what we believed to be a pretty thorough and careful survey of the state. I happen to know (and I don't believe this point was brought out) that same condition prevails in every one of the states immediately adjacent to or near the state of Florida. The result of our work was entirely negative. We didn't even find infestation in stored fruit. It so happened that practically all of our fruit in Mississippi came from the West Coast, which probably accounts for it. Some maggots were found in stored fruit in other states. We didn't even find maggots in stored fruit in Mississippi. We found no infestation of any description. I can't give you the exact number, but in thousands of inspections and in inspection of many, many thousands of bushels of native fruits in the state, that was the case.

The importance of carrying on that work in the future I do not think can be too greatly stressed, along the lines of the intensive work down in the state of Florida. I am sure the Department will see fit to continue that work if funds are provided. I should like to say that we in Mississippi are very much concerned about it for the protection not only of our own and the Gulf Coast, but for the protection of the fruit all over the state. (Applause)

Chairman Wallace: Surely some of you have some questions, something to say about it. I probably should not say anything about it, but I was very much interested in one very particularly dear friend of mine. He quit Florida when the Mediterranean fruit fly came in and came in to see me half a dozen times. Frankly, I didn't believe it could be eradicated. I gave him every reason in the world that it couldn't be eradicated and told him to stay in Indiana. He said, "Is that all you have to say about it?"

I said, "Yes."

He said, "I am going back to Florida. You don't know the people down in Florida. I do. They will do everything you have said and then some."

And he went on back. I haven't heard from him, but he said he was going to stick it out. I think maybe some of us don't know the people down in Florida, but I know some of you have some questions you would like to ask.

Mr. A. C. Fleury: I believe Dr. Newell and Mr. Strong both pointed out the importance of favorable public sentiment toward the success of

eradication campaigns of this sort. I am wondering how long there will be unfavorable public sentiment. Just so long as propaganda not based on facts is continually being thrust before these people in Florida, and those others to whom the Plant Quarantine Control Administration must look for financial support. I am not a scientist, but it seems to me that scientific conclusions should be based on facts. I think it is extremely unfortunate that some scientists have permitted their personal opinions to be voiced abroad, and have given to the selfish opponents of this eradication campaign ammunition which they would otherwise not have to injure the success of this eradication campaign.

It occurs to me, after Dr. Newell's talk this morning, that no person, regardless of whether he is an entomologist or not, but certainly an entomologist, can question the desirability and necessity for going ahead with an eradication campaign of this sort and carrying it out to a successful conclusion. I, for one, am certainly sorry that entomological propaganda has been issued which has given ammunition to those people who are selfishly opposed to the continuation of this eradication program. (Applause)

Dr. E. P. Felt: I have not been to Florida, and give voice to any views which I may have with only general knowledge in regard to the situation. It seems to me that unbelievable results have been accomplished and I have nothing but praise for what has been accomplished, and while I admit that mistakes have been made, we expect those in all large undertakings. It seems to me that the crucial point in regard to eradication of the Mediterranean fruit fly or any other insect does not depend so much on what you do in the very beginning, but it is going to depend on what you can do next year, the year after, and the year following, and perhaps the succeeding five to seven or ten or fifteen years, whatever the limit may be. That is, in other words, if you are going to eradicate (and I am using that in a strict sense), you have to carry through to the end. I believe the only way that can be accomplished is by laying out a progressive program. It is not so much what Congress or the state of Florida will grant next year; it is what the federal government and the state will make available through a series of years. I am inclined to feel a little this way: I am not opposed to eradication, but I would be a little inclined to feel that even if you could get an abundance of funds for this next year and the year after and then find it falling through, you might better keep out of the game.

That is just the history, to a certain extent, of the Gipsy moth work in the state of Massachusetts. They had enormous sums for a series of

years. They did good work. I happen to know something about it, and one of the important factors in making it impossible, physically speaking, to eradicate that insect, was due to the very high character of work that had been done. In the eradication of this Mediterranean fruit fly you have to face the situation where the honest administrator must admit that he hasn't seen a fly perhaps for one year, perhaps for two years, possibly for three or four years, and is still asking for one million and a half or ten million dollars, as the case may be, and get away with it. It seems to me that the only thing to do is to go to Congress with a comprehensive program, have them to understand the whole thing and let them know that the last fly is worth all the costs. (Applause)

Dr. T. J. Headlee: I was one of those who went to Florida very skeptical as to the possibilities of eradication. I came back convinced that the fly could be eradicated. There was the organization to do it and all that was needed was the money. I feel exactly the same way now. What is needed is money, and large amounts of money. The economics of the thing was studied pretty well by Dr. Cooper of the Commission to which Professor Dean referred. While this Commission made no recommendation as to money, amounts, or anything of that kind, the Commission did consider that the probable sum of money necessary to bring about eradication would be a most excellent investment from the standpoint of the United States.

I think that the practical end of this problem today is finance, and finance must come from the federal government. There is no sufficient amount of finance in Florida to handle a situation of this kind.

As far as people in our section are concerned, on that portion of the federal taxes which they pay (and it is pretty sizeable), I don't think there is the slightest objection to appropriations, federal appropriations, being made which carry a part of their taxes to the solution of this problem. I think that is the general feeling. I have had a number of talks with joint organizations, Pennsylvanians and New Jersey men, and as far as I can see that is their reaction, and many of these men are heavy taxpayers to the federal as well as to other taxing bodies. I have not had a shadow of a doubt that this bug can be exterminated. I feel that the only consideration is finance, and that that finance must be granted soon or the work will not be a success and the bug will get away. I agree with what Dr. Felt said about a well set forth program. I believe this organization has that program. I believe that the whole matter is being held up in Congress now because not enough people in this organi-

zation and elsewhere in this country believe that the thing can be done. If it can be done it is worth what it costs.

It seems to me we want to center our efforts, if we are backing this thing and believe it would be worth while, upon that phase of the question.

Now as to counter-propaganda issued here, there and elsewhere, we can take no notice of that except to answer it the best we can. That is a matter of freedom of speech. Every chap has a right to make his own notions known if he can and if he sees fit to do so. We cannot safely deny free discussion, but we should carry our end of this free discussion in a convincing and widespread manner so that we may produce the influence which is necessary to secure the funds.

As to rumors and reports and all that kind of thing, the world is full of them. It makes no difference. I saw nothing in Florida among the people and the conditions (and I will admit to you that I was skeptical and was looking for anything that might turn up) that gave any basis for the idea that the bug could not be exterminated or that the organization was not right. Therefore, my information endorses the work that has been done, the organization that is doing it, and the practicability, with funds, of exterminating the insect. So we must center upon the question of finance, and what this organization can do in that direction is more or less problematical, but I will say to you that if you got out and tried you would be surprised at what you could do, because most of you have got the confidence of your people back home and of men whose word to the Representatives and Senators in Congress mean something. There is, to my mind, in this organization right here and now a corps of men who, if they became active, could insure adequate appropriations for carrying on this work. (Applause)

Dr. Newell: If I may be pardoned for speaking again, we have discussed the present situation and the past, and not very much has been said about the future. We might give some thought to what is likely to transpire if the eradication of the fruit fly in Florida should fail. The best protection that any state could have, if invaded by this pest, is its extermination. It is better for the battle to fall in the other fellow's territory than in your own. If you have ever been subjected to the losses, the inconveniences due to quarantines which go with a pest like this in your territory, you will appreciate it.

It seems an unquestionable fact that this insect will be able to do great damage to a very considerable number of the major crops in the southern and most of the western states. It is conceivable that it might

be a pest of very serious consequence in what we might call the middle states. In the event it does spread through the country, especially the South and West, I am thoroughly convinced, at least from what I have seen of its capacity for destruction, that it will be necessary to revamp the entire program of agriculture in the South and West. Major crops have passed out in the past because of the ravages of insects and disease, and they can pass out again. If this insect gets a foothold and gets away, I am satisfied that the big commercial peach crop of the South is gone. Whether the citrus industry would go or not, I do not know, but certainly a revamping and a re-arranging of the entire agricultural program, with the re-arrangement of the business structure which rests upon that agricultural program in the South and West, would be necessary. Those of us who have worked in the South know what a revolution in that respect was brought about through the invasion of the boll weevil, but I believe this insect is capable of bringing about a greater revolution, and with it much greater losses in the possibility of adjustment. If that takes place, Congress will be called upon to appropriate many millions of dollars for extending and expanding the research work in agriculture in connection with these changes which will have to be made, and along with it Congress will be called upon and will have to appropriate much larger sums for agricultural extension and educational work than it is appropriating today.

Look at the thing in any way you wish to, anything except eradication means any expense for the United States Government and for the state. When you begin to think it over, you will see that any reasonable amount Congress might appropriate for the complete eradication of the fly will be money well invested, and will be the means of saving a great deal of money not only for the southern fruit man but for the nation.

The President, on December 9, sent a special communication to Congress, which was concurred in by the Bureau of the Secretary of Agriculture, in which he recommended an appropriation of $15,381,000, the great bulk of which was for eradication measures, the balance for prevention of spread, inspection, and importing. That sum, large as it looks, is but a very small part of the annual losses which we may expect in agriculture and business if this insect gets away from us. (Applause)

Dr. T. J. Headlee: I think we need to get down, perhaps, to a definite point. If I am a little out of turn, I beg your pardon. It seems to me that we need to know how much money, in the judgment of the organization doing the work, is needed from Congress for the coming year. In this organization here men cannot be definite in dealing with

their people without that information. If that is extant, and I think it is from the words I heard from Professor Newell just now, let's hear what it is so that we will know definitely the figure and can talk to it in the places where it will do the most good.

Mr. Strong: The message Dr. Newell referred to is contained in a public document, I think, No. 145. It is available to anyone by writing to a member of Congress. It certainly is available to every member of Congress. It asks for an appropriation, as Dr. Newell pointed out, of $15,381,000. The message by the President stated that if this money was not appropriated, the money we had at that time would be exhausted by December 15. Naturally, we couldn't go right up to the last moment spending the last cent we had, then stopping short. We had good judgment, and business administration would dictate to carry on as much of the work as we could, making things as safe as we could until the money was appropriated.

On the eighteenth or nineteenth of December (I have forgotten the exact date) an emergency appropriation, as such, of $1,290,000 was made by Congress, a joint resolution, and signed by the President the following day. The $290,000 was to replace the ten per cent allocation of funds made by the Secretary of Agriculture from existing funds in the Plant Quarantine and Control Administration diverted to fruit fly work, so that gave us, after the $290,000 was replaced, $1,000,000 to carry on the work in Florida.

This estimate was based on the best judgment of the people who were in the best position to know what was needed for this work, the people actually on the ground in Florida and actually doing the work.

Because $15,381,000 was asked for, doesn't necessarily mean that every cent of that would be expended by next July 1, but we want to be prepared for any emergency which may arise in this fruit fly fight. It may develop that half of that money wouldn't be spent before July 1, but if we need the money we need it right now. We aren't going to be able to say we need a certain amount, and no more. It may develop that more money than that will be needed before the fight is won. It doesn't necessarily mean because that amount was asked for, that every cent is going to be absolutely spent, but we have to have enough money to insure carrying this work to a satisfactory conclusion.

Conditions that existed at the time this estimate was made have not changed in the state of Florida. Save for the finding of the one infested orange in Florida, conditions are identical with the time the estimate was made. That is exactly what the situation is today.

We are not resenting, and we don't care about the criticism that is coming. It doesn't amount to anything except that it illustrates that the same condition exists now as always exists whenever one of these situations arises, that a very few people who object to anything always make themselves heard. The great majority of people keep still. We know that the reasonable people of this country don't want the Mediterranean fruit fly to exist in the United States any place. Anybody knows that.

We know that these quarantine restrictions are burdensome. We want to relieve Florida of these quarantine restrictions just as soon as possible to do it, and we don't want to extend them to every state. The Quarantine Act makes it mandatory on the Secretary of Agriculture to take steps to prevent the spread of insects when they come into the country. The best way to prevent spread is by eradication. That is what we want to do in this case. This is a plain open and shut case. The amount of money is before Congress, directly requested by the President and the Bureau of Agriculture. Conditions have not changed since that estimate was prepared, so far as I know.

MR. STRONG: We expect the work will go on, and I agree with Dr. Felt that a program should be laid out; but at the present time this situation is not so that you can lay out a definite program over a period of years. We have to have this money for the next few months to find out just exactly what we are going to do. There will have to be another appropriation made, certainly.

DR. HEADLEE: I don't know, Mr. Chairman, the best way to organize this thing and shape it up. I am not looking for any job in connection therewith. That is distinctly understood. I am outside the zone of that kind of thing.

It seems to me, to bring this thing to a point, you have to have an organization, and probably the best organization is a good, live, active committee that will keep the boys over the country stirred up and keep things moving. This suggestion I am making may not be in place, Mr. Chairman. I am making no motion because I am not sure, but that is a suggestion of the organization that should be proposed. There should be some.

CHAIRMAN WALLACE: I would hesitate to do anything that wouldn't meet with the approval of the Florida people. They are the ones who know what they are doing. They have their program outlined. Certainly, I would welcome a motion from them, or even a suggestion, and then would appoint a committee, and would like to get a committee that would work with them.

MR. J. H. MONTGOMERY: It occurs to me that we already have an organization which could properly handle the situation as it presents itself today. If there ever was a time since the creation of the National Plant Board and its regional constituent boards when its existence and their existence could be justified, that time exists right now. I know of no organization that now exists, or that could be created, which would wield the influence that the National Plant Board and the regional boards could under this condition which now exists in the emergency that confronts us. That organization and its constituent bodies can reach every single individual, it occurs to me, who is affected either directly or indirectly. As a result of its activities, it certainly should be able to create a most favorable sentiment that would be nation-wide.

Now, Mr. Chairman, while I am on my feet, may I be permitted to touch upon one aspect of this situation which has only been scratched, and that is the effect upon the consuming public of the United States in the event that we have, as the expression is, to live with the fly.

Reference has been made to the cost of eradication. Reference has been made to the economic disturbance in the affected area. Reference has been made to the probable and possible cost of a reconstruction period, but no reference has been made to the effect upon the consumer of foods. An insect of this nature, that can habituate itself and become acclimated over a wide number of areas, with an immense number of host fruits and host vegetables, and with its propensity to create enormous damage, will bring about curtailment of production and you have with it a corresponding rise in the cost of foods. So there is not an individual in the United States who is not affected by the situation which, to many of you, now appears to be a local condition. It is a national problem and not a state problem.

CHAIRMAN WALLACE: Mr. Montgomery, the Plant Board is going down to make an investigation. Whether we could definitely tie up their visit with this meeting or not, I do not know. I see no reason why we could not, and rely on their report to come back here. It certainly represents this body better than any other group that we could get out. Each of our regional boards have delegated representatives and they are going. It would certainly be our report when it came back.

Is there anybody else who would like to be heard?

I almost hesitate to cut off discussion because I consider it of far more importance than all the rest of the things we have put together.

I am going to skip "The Pine Tortoise Scale in Nebraska" for just a moment, and ask Dr. Fracker to take up the "Transportation Systems in Their Relation to the Enforcement of Domestic Plant Quarantines." It ties up with what we have just been talking about.

TRANSPORTATION SYSTEMS IN THEIR RELATION TO THE ENFORCEMENT OF DOMESTIC PLANT QUARANTINES

By S. B. FRACKER and R. A. SHEALS, *Washington, D. C.*

Plant quarantines may be defined as official regulations issued for the purpose of preventing the spread into new localities of plant diseases and insect pests attacking various kinds of plants. They attempt to cover, so far as possible, all means of distribution of the insects and diseases concerned, with the exception of wind carriage and flight which are methods of dissemination over which there seems to be no means of control. The establishment of the present system of plant quarantines has been necessitated by, and its growth has been coincident with, the enormous development of the world's commerce during recent years, which in turn has been brought about by improved methods of rapid locomotion.

The enforcement of plant quarantines must be based on two types of information, first, knowledge as to the products or articles with which the insect or plant disease is likely to be associated and with which it may be carried; second, the means of transportation which may be employed in moving such articles from one point to another. It is our purpose in this paper to outline one phase of the second of these problems so far as it relates to the continental United States.

The transportation of articles in this country for more than the briefest distances involves the use either of highway vehicles, boats, railroads, or airplanes. Of these, automobile and truck transportation is brought under control by road stations, boat movement by port inspectors, and rail traffic by transit inspectors. While airplanes may prove a fertile source of difficulty in the future, articles carried by them are at present handled through established postal and express channels and are therefore available for examination to the same extent as mail and express moved by rail. This paper will be devoted to a discussion of movement by rail and the possibility of examining materials so transported to determine compliance with quarantine regulations.

As each State has hundreds of post offices and shipping points, attempts to control rail movement completely at either source or destination face almost insurmountable difficulties. No quarantine enforcement organization could within a reasonable cost, detail a competent inspector to every post office, express office, and railway station, within a large infested area to be sure that no contraband materials were accepted for shipment. The best that such an organization *within* the infested area can expect to accomplish is to inform the employees of

common carriers of quarantine regulations in order that they may use as much care as possible to prevent the shipment of contraband articles.

Certain of the southern and western States recognizing this difficulty have made provision for inspection at destination rather than the source, but only States having large horticultural interests can afford the expense which an organization of this kind entails. Accordingly, the United States Department of Agriculture has, for several years, been giving attention to the possibility of enforcing quarantine restrictions with respect to movement by rail by the examination of materials *in transit* at strategic distribution points. The success of such a system depends on the extent to which inspectors at a limited number of points are able to make observations on a maximum proportion of the total traffic involved.

The function of the transit inspectors is not to determine the presence or absence of pests in the material passing through their hands, but to ascertain that the safeguards required by the control regulations have been complied with. As examples, they make sure that nursery stock from the Japanese-beetle-infested area bears Federal certification showing that the material has been inspected and found free from infestation; they determine that no embargoed plants, such as white pines from white-pine-blister-rust infected States, are moving to non-infected States, and that currant and gooseberry bushes, are shipped dormant or defoliated from the blister rust infected sections of the country; they check on shipments which may contain cottonseed or other cotton products from pink-bollworm or Thurberia-weevil-infested areas; and they are given the responsibility of seeing that railroad cars which have been employed in the transportation of host fruits and vegetables from the territory under regulation on account of the Mediterranean fruit fly outbreak are cleaned at the unloading point before being sent back to loading territory, where any infestation which there might be in the car would prove especially dangerous. Shipments found to be moving in violation of quarantine are turned back to the shipper and the evidence is referred to the field quarantine unit concerned for investigation and possible prosecution.

PARCEL POST. The Post Office Department, which has complete jurisdiction over the mails, has established a definite scheme whereby parcel post shipments to points 150 miles or more from places of origin are consigned to and sorted at one or more of 47 terminal transfer stations. These concentration points are located at strategic railroad junction centers throughout the United States. All parcel post is

consigned through the mails in one of three ways, namely: in sacks addressed direct to one of the 47 terminal stations, in station-to-station sacks ("directs"), or as outside mail.

Sacks addressed to a terminal usually contain parcel post consigned to points in a single State and are sent direct to the terminal at which, according to the postal scheme, such shipments are to be distributed. For example, parcel post from New England to California is sent direct to the Van Buren station at Chicago, sorted there and sent on in sacks to towns of destination in California.

Station-to-station sacks ("directs") are used when there are enough consignments from a certain post office to a definite point of destination in any State to fill a sack. Such shipments are consigned direct to destination without being sorted at any point en route.

Outside parcel post consists of shipments too bulky to be inclosed in sacks, shipments of a perishable nature (nursery stock is not classed as perishable by the Post Office Department) and special-handling packages. They do not go direct to the main sorting rooms in the terminals. Space is usually provided in the basement or on the track level of the railroad stations where such shipments are distributed on trucks, according to the train on which they are to be dispatched. Outside parcel post and direct sacks are frequently transferred direct from train to train. This practice is called direct transferring and takes place only when close connections are made between trains.

Transit inspection methods are based on studies of the routings used by the Post Office Department and the common carriers. The 47 terminal transfer points mentioned are the "bottle-necks" through which more than 95% of all long distance shipments of parcel post, express and freight are consigned for distribution and at which they are available for inspection.

Under an arrangement with the Post Office Department, parcel post packages may be checked by inspectors of the United States Department of Agriculture as to compliance with plant quarantines at any point where the packages themselves can be seen. The so-called outside parcel post to which reference has been made may obviously be examined at any point en route when it is outside the mail car or where the car is opened, but since most shipments for any considerable distance go in sacks addressed to terminals and while en route are not outside such sacks except within the terminal office building, the most desirable points at which to inspect parcel post are the distributing offices in the 47 cities referred to. About 18 of these cities are of much less conse-

quence than the remaining 29. The Department of Agriculture has thus far done some work in about half these 29 important terminals and it is hoped that as funds are made available inspectors may be placed in the others at least during the season involving the greatest danger of transportation of plant pests. It is not anticipated that under present conditions the 18 smaller stations are likely to require attention except possibly for short intervals during the spring and fall nursery stock shipping seasons.

Within the terminal, parcel post shipments are all handled one or more times by the postal employees. These employees have in most cases had several years' experience and their ability to determine the nature of the material inside packages is surprising. The postal authorities cooperate by instructing these employees to hold out for inspection all shipments containing plants or plant materials or any shipment they may have reason to suspect may contain materials subject to Federal plant quarantines. The inspectors also have access to such shipments. The superintendent of one of the largest terminal points stated, after studying the work of our men in cooperation with those of his own force, that he could not see how a single shipment containing materials subject to Federal plant quarantines could pass through that station without being held out for inspection. Owing to the excellent spirit of cooperation on the part of postal employees, it is thus possible for one Department of Agriculture inspector to check on all packages containing perishables originating in, destined for, or passing through cities even of considerable size, although obviously a number of inspectors are required to take care of the entire traffic of such cities as Chicago and New York.

Express. The methods of routing of express shipments are comparable to a large extent with those outlined for parcel post except that practically all express shipments travel as outside packages. Sacks and other containers are used only in case of certain shipments of high value. The express sorting rooms are usually located in buildings adjoining the railroad stations, although in some large cities, due to congestion, the Railway Express Agency maintains separate express yards in the outlying sections to which all incoming express cars are consigned for unloading and from which local dispatch and transfer operations are made. These yards or separation stations are located at strategic railway junction points, usually in the same cities as postal terminals.

Some direct train to train transfers are made. Such operations take place on the train platform at the railroad stations.

Inspection of express shipments presents a comparatively simple problem. The packages are usually wrapped in such a way that the contents may be readily ascertained. The waybills contain the consignor's declaration of contents and while such declaration cannot be absolutely relied upon, it serves as an assistance to inspectors.

In sorting rooms and in the cars, express employees assist materially by piling shipments of nursery stock and other materials subject to quarantines in places where they may readily be inspected. The inspectors do not rely on express employees to hold out shipments. Regular inspection tours based on train schedules are made, and during these trips, inspectors make the rounds of the sorting rooms and the loading docks where outbound shipments are being loaded prior to train dispatch. As a rule a few trains carry the bulk of shipments to be inspected. Such incoming trains are included in the tours and inspections are made either prior to unloading or at the separation docks immediately after unloading and before separations are made.

Studies of direct train to train transfers have also been made and all important transfers are included in the tours.

The cooperation of the express officials and employees is excellent. During preparation of the tours in Chicago, express employees were stationed for a period of more than a week at each incoming express car and exact counts of all shipments of nursery stock unloaded were made. This information was of material assistance in enabling inspectors to know from what points and on which trains such consignments are made. Inspectors have information in advance of any change in train schedules and are thus able to arrange their tours to correspond.

Freight, Less Than Car Lot Shipments. Shipments by freight are made in one of two ways, as full car lots or as less than car lots (L.C.Ls). These two methods offer entirely different transit inspection problems.

L. C. L. shipments are transferred from one car to another at concentration points where they are available for inspection. In some instances, a shipment may be transferred several times at different points until a full car for the destination concerned is assembled. If only a few consignments are available for a given point, they are usually sent by local way freights to destination.

The number of freight transfer points at a large city may be very great. In Chicago for example there are 250 freight yards scattered throughout the city. It is obviously impossible for a force of five men (the average number of inspectors available in Chicago for the past two seasons) to visit all these points each day. The freight companies

cooperate in helping solve this problem whenever requested by furnishing inspectors with copies of waybills covering all plant shipments. These waybills are received prior to the arrival of the shipments. Arrangements have been made whereby the freight agents report each day by telephone the number of shipments on hand and the waybill numbers. The tours are arranged from information thus obtained.

The exact location of the shipments in the cars on the sidings is obtained from the freight box office. The declaration of contents given by the consignor on waybills may be relied upon to a greater extent than in case of express waybills because freight rates are based to a great extent on the nature of the contents. The freight companies have men employed to check on false declarations.

The usual type of shipment by freight is easily inspected. In most cases the removal of one board allows inspection of the entire contents. If individual wrapped packages are contained in a shipment the problem is more difficult. Occasionally the material is so tightly packed that inspection en route is not possible. In such cases inspectors report the shipments to the State inspectors at destination. Several violations have been intercepted in this manner.

CAR LOT FREIGHT SHIPMENTS. Car lot shipments go direct from point of origin to destination without being transferred en route. Their compliance with quarantine regulations can often be determined directly from the waybills and accompanying papers.

The manner in which this works out in enforcing plant quarantines is well illustrated by the problem of enforcing the Mediterranean fruit fly requirements subsequent to the outbreak of that pest in Florida. Control of the transportation of Florida host fruits and vegetables (after the elimination of mail and highway movement by direct embargo under the Federal quarantine) resolved itself into, first, governing the movement of solid cars of fruit; second, controlling individual box shipments sent by express; third, preventing reshipments of fruits authorized movement into the north but prohibited transportation into the south; and fourth, the enforcement of car-cleaning requirements and preventing the transportation of uncleaned refrigerator cars which had been used for the transportation of Florida host fruits and vegetables, from the unloading point to new loading territory.

The physiography of the eastern United States is such that while there is a general network of railroads which may be noted on any railway map, practically all movement between the northeastern States and the southeastern States, whether such movement is northbound or

southbound must go through the city of Washington. This fact has resulted in the development of extensive freight yards known as Potomac Yards, Virginia, on the south side of the Potomac River. Except for a railway line through the Shenandoah Valley, the next point west of Potomac Yards through which traffic can reach the northern States is at Cincinnati. Control of movement at Potomac Yards with respect to shipments from Florida means that all products going into the heavily populated consuming markets of New York, New Jersey, Pennsylvania and the New England States (an area which includes more than one-third the entire population of the United States) may be seen in these freight yards. It has, therefore, been possible from the first day that the quarantine was established to be sure that the movement of fruit into this important consuming area was confined to shipments made in full compliance with the regulations and without serious danger of bringing the Mediterranean fruit fly.

Points at which the Ohio and Mississippi are crossed by rail offer similar opportunities. From Cincinnati west to the Rocky Mountains, the freight yards at Louisville, Evansville, Cairo, St. Louis, and Kansas City, practically control distribution.

Florida, fortunately from the standpoint of quarantine enforcement, consists largely of a peninsula, with the railroads leaving the State either through Jacksonville or Pensacola, and farther north passing through three or four important distribution points, the most significant being Waycross, Savannah, and Atlanta, Georgia. It was possible for inspectors checking on waybills on freight trains at these points to be sure during the summer and fall (prior to November 21) that no Florida host fruits or vegetables were billed to points in the southern States except for diversion to the north, and once they reached the north such shipments were under full control by inspectors located at the junction points named. A full record of every car of perishables passing Jacksonville and Waycross is received every day by the Domestic Quarantine Office of the Administration and any irregularities are readily detected either at Washington or before the cars leave the State.

This same development of the transportation system made it possible to bring the car-cleaning requirements into operation with the least possible delay. Florida host fruits and vegetables in car lots are normally consigned to 200 or more cities in the northern United States. To place inspectors at all of these points was out of the question. Several representatives of the Administration were assigned the duty of traveling from point to point and familiarizing the railroad employees concerned

with the requirements of the regulations, but the most important enforcement measures consisted of the establishment of inspection of empty refrigerator and ventilated cars after these cars left the unloading point and were moving again to loading territory in the south and west. Six employes of the Department at the junction points named, with a limited amount of assistance from railroad employees, have been able to inspect practically all such southbound empty refrigerator and ventilated cars and see that those which have not been properly cleaned are diverted to cleaning yards at the junction points themselves. The railroad on which the uncleaned car is found then in some cases charges the cost of cleaning against the railroad which had the car at the time it was unloaded, but in any event the car is not allowed to proceed to loading territory until it has been thoroughly cleaned.

This discussion of the Mediterranean fruit fly quarantine enforcement has been introduced as illustrative of the manner in which a knowledge of the transportation systems of the United States may be used in the enforcement of a particular quarantine. There are a few bottlenecks through which practically all traffic between important sections of the United States must move. These are partially due to the presence of mountains, rivers and other physiographic features and their effect on the engineering requirements of railroad construction, but more largely to the fact that the railroads themselves have taken advantage of these features by establishing at strategic points a limited number of freight yards and express distribution platforms at which the transfer of cars or less than car lot shipments from one railroad to another may be arranged. By taking advantage of these features of the transportation systems of the United States it is possible for those interested in the spread of plant pests to prevent the transportation from infested to uninfested sections of the United States of materials which might be carrying plant pests to new localities.

RESULTS. The number of interceptions of quarantine violations reported by transit inspectors since the work started was shown in tabular form. The work was originally undertaken by the Office of Blister Rust Control of the Bureau of Plant Industry and, prior to 1927, was confined to the enforcement of the blister rust quarantine. Since then, inspectors have intercepted as many violations of other domestic quarantines as they could discover, the work being supported by assignments of funds from the special appropriations for the enforcement of the various quarantines. Under the pending agricultural

appropriation bill for the fiscal year 1931, provision is made for the establishment of this work as a separate project.

CHAIRMAN WALLACE: The next paper is "The Pine Tortoise Scale in Nebraska," by L. M. Gates.

THE PINE TORTOISE SCALE, *LECANIUM NUMISMATICUM* PETTIT AND McD., IN NEBRASKA

By L. M. GATES

ABSTRACT

The pine tortoise scale, *Lecanium numismaticum* Pettit and McD., has recently caused serious injury to plantings of Jack pine and Scotch pine in the sandhill region of Nebraska.

An application of a commercial white oil emulsion used at 2% to 3% strength during the first two weeks of July, gave excellent control of the insect without injury to the trees.

The pine tortoise scale, *Lecanium numismaticum* Pettit and McD., was first reported in Nebraska in April 1911. This infestation was in eastern Nebraska. Two other localities in this part of the state reported infestations of this insect in 1919 and 1923. In 1916 an infestation was reported in the heart of the sandhill region near the town of Thedford and in 1924 another report was received from the sandhills in southwestern Holt county. In 1928 the insect was found for the first time in the Nebraska National Forest near Halsey, where over twelve thousand acres have been planted to pines during the past twenty-five years.

The size and importance of this planting as well as the value of the many ranch plantings in the region made it seem advisable to determine if possible the source of the infestation in the forest reserve and to work out practical control measures for this pest, which had already demonstrated its ability to not only seriously retard the growth of the trees but also in some cases to actually cause their death.

The first step taken was a survey conducted during 1928 and 1929 by the Supervisor of the Forest Reserve and the Extension Forester of the College of Agriculture co-operating with the State Department of Agriculture. This survey revealed three, more or less, isolated areas of infestation. One of these was about twenty miles northwest of the forest reserve and the other two about seventy-five and one hundred miles respectively, northeast of the reserve.

Approximately one-third of the plantings inspected were found to be infested with scale. In some cases very little damage was apparent

while in others many of the trees were either dead or dying. Badly infested plantings were easily located, even from a distance, by their darker color caused by a black fungus growth on the honey-dew secreted by the insects.

SOURCE OF INFESTATIONS. Although some of the infestations near the forest reserve were severe and apparently of several years standing, the center of infestation seemed to be in southwestern Holt county where an experimental planting was started in the spring of 1891. The Jack pine trees in this planting were seedlings "dug from the forest in Wisconsin" except a few nursery grown plants used for comparison. At the time of the survey most of these Jack pine trees were dead while Western Yellow pine trees which are not attacked by the scale, were healthy and vigorous. It is interesting to note that the trees constituting the first reported infestation in the state were also thought to have been dug or pulled in Wisconsin. Furthermore, *Lecanium numismaticum* was described from specimens collected in Wisconsin.

From this evidence it seems probable that the original infestation in the sandhill region may have been the 1891 planting and the source of the pest the Wisconsin forest pulled seedlings. Also it seems that the insects have been carried in the crawler stage, from one planting to another by crows or other birds. Crows are very abundant in the sandhills and the pine plantings seem to be especially attractive to them as roosting and nesting sites.

It was at one time thought that the scale was introduced into Nebraska on young Jack pine trees from Minnesota since many of the ranchers secured their planting stock from a nursery in that state. However, the owner of the nursery does not seem to have been familiar with the pest according to a letter received from him. Also, in one instance two neighboring ranchers planted trees from the same shipment from the Minnesota nursery and one of these plantings has no infestation while the other is badly infested. The two plantings are less than two miles apart and have been planted about fifteen years. Furthermore, the first planting of Jack pine in the Nebraska National Forest consisted of seventy thousand wildings from Minnesota and no scale was found in this planting until twenty-five years later.

While this species or a similar one has been reported from eastern nurseries by Dr. L. O. Howard, from New Jersey by Dr. T. J. Headlee, and from the south by E. W. Hadley, we have no records of trees being brought into Nebraska from these regions. Recently it has been reported doing serious damage to Jack and Scotch pines near St. Paul, Minnesota.

LIFE HISTORY. A detailed study of the life history of this insect has not been made. However, it has been observed that there is but one generation a year in Nebraska and that the females winter in about a half-grown condition. The males apparently emerge in the fall, their white cocoons being conspicuous on the infested branches at that time. The first crawlers were observed in the laboratory about June 8th and by July 1st they had practically finished hatching in the field.

HOST PLANTS. Only Jack pine and Scotch pine have been found infested in the sandhill region of Nebraska although Austrian pine is grown in the infested region and Western Yellow pine is quite common.

CONTROL. The first remedy suggested was kerosene emulsion which did not prove satisfactory both because it failed to control the scale and because it sometimes was injurious to the trees. It was later suggested that by cutting out all infested trees the insects would be eradicated. This method has been used in the National Forest with apparently good results. Three infested areas totaling about two acres of trees have been cut out in the past two years and at this time none of the insects are known to be present on the reserve. However, it is realized that there may be some survivors that will cause a new outbreak later. The cutting method has been used for several years on one of the ranch plantings but eradication has not been accomplished and the rancher is becoming fearful that he will eventually lose all of his trees.

Since the state authorities wish to encourage tree planting, the recommendation that the trees be cut out seemed a little inconsistent and it was therefore decided that an experiment in spraying would be desirable. To that end the State Department of Agriculture purchased a power sprayer in June 1929, and in co-operation with the College of Agriculture, the State Game, Forestation and Parks Commission, the California Spray Chemical Company, and the U. S. Forest Service started the sprayer in the field July 3rd. The intention was to apply the spray during the hatching period. However, no crawlers were found during the time the sprayer was in operation, most of the insects being newly established on the twigs without the waxy covering with which they are eventually covered.

The spray materials used were Volck light, Volck heavy, Orthol-Kleenup and, in combination with the first two, "Black-leaf 40" at the rate of 1–800. The oil emulsions were used in dilutions of 2%, 2½% and 3%. Both Jack pine and Scotch pine were sprayed. The spray material being applied under 275 pounds pressure with an orchard spray gun. The weather conditions were not favorable for use of oil

sprays, being hot and humid. In spite of these adverse conditions no burning has been reported on any of the sprayed trees. Furthermore, very good control was obtained. In some of the plantings no live scale could be found a month after the trees were sprayed. Other plantings showed some live scale that were apparently missed when the spray material was applied. Even these plantings showed much improvement in the condition of the trees.

An additional experimental spraying was applied on two plantings October 15, 1929, consisting of Orthol-Kleenup at 6% strength. One of these plantings had been previously sprayed and very good control obtained, the other had not been sprayed before and some of the trees were heavily infested. There has been no check-up of the results of this spraying.

Plans have been made to continue the experiment with dormant strength oil sprays just before growth starts in the spring. This should give information as to whether summer, fall or spring spraying is most effective.

References

1891. Report of the U. S. Dept. of Agriculture, pp. 206–211.
1893. Ann. Report of the Nebr. State Hort. Soc., pp. 46–57.
1907. U. S. Rept. of the Entomologist, p. 31.
1909. Jour. Ec. Ent. p. 447.
1915. N. J. Rept. of the Entomologist, p. 315.
1920. Tech. Bul. No. 48, Mich. Agri. College.
1925. Extension Bul. No. 76, Mich. Agri. College.
Jour Ec. Ent.—October 1925.

Chairman Wallace: We will now hear a paper by E. L. Chambers.

HOT WATER TREATMENT OF NARCISSUS BULBS IN WISCONSIN

By E. L. Chambers, *Madison, Wisc.*

While Wisconsin is not one of the states in which narcissus bulbs are being grown on a commercial scale, there are two firms in the state that force annually nearly a quarter of a million of these bulbs. Both of these florist establishments are located at Milwaukee, one growing the bulbs that it uses for this purpose while the other purchases forcing stock from out-of-state sources each year. In order to make sure of an adequate supply of good quality vigorous forcing stock to meet their needs after the embargo was to go into effect during the fall of 1926, the Holton & Hunkel firm was compelled to grow their own stock. While this project

was first undertaken in 1924, it was necessary to secure several tons of bulbs in 1926 just prior to the time when the embargos became effective. In order to comply with the requirements of the narcissus quarantine at that time they were obliged to arrange for the treatment of the bulbs with hot water, recognized as a means of controlling infestation by the nematodes, *Tylenchus dipsaci* Kuhn, and the bulb flies, *Merodon equestris* and *Eumerus* spp.

When the firm attempted to purchase such equipment as would be adequate to provide a temperature ranging from 110° to 111.5° over a period of 2½ hours, as specified by the requirements of the quarantine, they found that such apparatus was not available on the market and consequently set about to devise their own. Mr. H. H. Hunkel of this firm at first considered it almost humanly impossible to maintain a temperature at the limits set by the quarantine regulations but was able in a few months to build a sterilizer which met these requirements almost to a point of perfection and has used it successfully over a period of four years.

This equipment, consisting of a large round bottom rectangular, iron tank, with an agitator, rotary pump, and a boiler, was built out of doors. The tank is 8 feet 6 inches long, 3 feet 3 inches wide, and 4 feet deep to the bottom of the curve. It is sufficiently large to take care of 5 trays holding approximately a half ton of bulbs at one time. The trays, covered with quarter inch wire screen, are built so that they will set down into the water with the weight resting on the handles at the top which extend over the sides of the tank to permit of easy handling and at the same time hold the trays a foot off of the bottom. The tank is mounted on a frame elevated on legs a foot above the ground. Stationed about four feet from one end is a 2 H. P., internally fired, steam boiler connected to the tank with ¾ inch pipe leading to the opposite end where it enters from the top of the tank, running down the inside to a point at the base of the rounded bottom. Here at this point there are installed two brass 8-inch propellers, four feet apart and reversed, on a shaft running two-thirds the distance of the bottom of the tank. This shaft is driven from the outside by a chain on an 8-inch sprocket wheel driven by a 4-inch sprocket wheel on another shaft running the length of the tank at the level of the top. The opposite end of the shaft drives a 4-inch pulley on a rotary pump with a belt leading to a 10-inch pulley. This shaft is driven from a 10-inch pulley at the opposite end where it is connected by a belt to a 2 H. P. electric motor, making 1750 revolutions per minute. The pump will deliver about 50 gallons per minute and the

agitator makes about 850 revolutions per minute. The steam boiler is only 18 inches in diameter and 44 inches high but has sufficient capacity for twice the load it carries in doing this work.

In operating the sterilizer the water is first heated by running live steam into the partially filled tank. To offset the cooling temperature effect of the bulbs the temperature is first raised to about 115° F. It takes from three to five hours to do this, depending upon the outdoor temperature and the amount of wind. The bulbs are then inserted in the trays and the pump circulates the water through a heater adapted for this purpose. A heater was mounted midway between the pump and the top of the tank on the 1½-inch pipe returning the water to the agitator at the opposite end of the tank and running parallel with the steam line. This heater consists of a 2-foot length of an 8-inch pipe with a ¾-inch copper coil running through it into which steam is circulated and the water is heated as it is pumped over it. While the amount of steam needed to maintain the desired temperature for a period of 2½ hours might be secured by simply "cracking" the valve to allow the necessary amount of steam to pass, a more satisfactory control was worked out by a cut-off consisting of a series of four valves arranged on different sizes of pipe having a range of 3/8″, ½″, ¾″, and 1″, respectively. While some adjustment has been necessary with unfavorable weather conditions it has been frequently possible to run the desired temperature for almost the entire period without making any adjustment. Although it was thought at first that getting a control within a degree would be next to impossible, it has been demonstrated in the four years the machine has been in use that even a very small fraction of a degree variation can be secured.

Such a pronounced invigorating effect was noted from the use of hot water at the required temperature that while the owners of this equipment do not make any shipments which would require the continuing of this treatment, they feel it well worth while to continue for their own good. The bulbs used for planting out for propagation are planted as soon as they are cool, the bulbs are spread out on a packing house floor to dry sufficient to permit of convenient handling and then planted before they become completely dry. Those used for forcing are of course allowed to dry off until needed for forcing.

Another firm in Milwaukee, forcing around 100,000 narcissus each year, sells its forced bulbs each fall in small lots and to comply with the quarantine regulations it was necessary one year to have their bulbs treated with this equipment before certification, although only a trace

of one of the species of nematodes was found, otherwise the bulbs could not have been disposed of. The bulbs are treated usually during the last week of August or the first week in September.

In the four years that this treatment has been in use no injurious effects have been noted from its use and 100% control has been secured of the various nematodes, bulb flies, and in addition the bulb mite, *Rhizoglyphus hyacinthi*, which sometimes becomes very abundant on bulbs in Wisconsin. The bulbs used for forcing are found to bloom a week or so earlier than checks which were not treated and the color and quality of the bloom has shown a decided improvement. Certain varieties, such as Von Sion, which fail to produce good color in Wisconsin were at first thought to be a result of hot water treatment but it has later been demonstrated that the untreated ones grown here along side of those treated, also showed a tendency to a green tinge in the bloom. This variety, which does well out of doors, is a very prolific bloomer and multiplies rapidly, is being abandoned in Wisconsin although until recently most extensively grown of any of the varieties. With the exception of this variety the Holton & Hunkel Co., has been able to grow just about as good forcing stock as they formerly imported and each year they are gaining experience which enables them to improve on the quality. Bicolor Victoria, Emperor, Spring Glory, Golden Spur, Martha, King Alfred, and Empress are the principal varieties now being successfully grown in Wisconsin for forcing. Basal rot, while present, has not been of sufficient importance in Wisconsin to require any additional precaution in treating with hot water, the visibly infected bulbs being sorted out when they are cleaned preparatory to treating.

CHAIRMAN WALLACE: The next paper is by Dr. K. C. Sullivan.

THE PRESENT STATUS OF THE PLANT INSPECTION WORK IN MISSOURI

By K. C. SULLIVAN, *Plant Commissioner, Missouri State Board of Agriculture*

The Missouri State Board of Agriculture in 1869, published C. V. Riley's first Missouri report on "Noxious and Beneficial Insects." This was the first of a series of nine brilliant reports, and the first important entomological work carried on west of the Mississippi River.

Thus the Missouri State Board of Agriculture was a pioneer in fostering entomological work. The Board, however, discontinued its support of entomological work when Riley left Missouri, and it was not resumed until the present time. The resumption of support of this type of activity has been brought about by the rapid development of the in-

spection and regulatory phases of entomological and plant pathological work. This development of the inspection and regulatory work has undoubtedly been due to the fact that the public has come to more fully realize the great importance of preventing, eradicating, or controlling those insect pests or plant diseases which compete with man for food upon which to live.

Laws governing the transportation, and disposition of materials which may serve as a means of bringing about the dissemination of insect pests and plant diseases are unfortunately of quite recent origin. Their economic value, is now, however, recognized by most everyone. As time goes on, we will without question resort still further to our legislative bodies for legal instruments to assist us in the warfare against our insect enemies and plant diseases. It is probably unfortunate that it is necessary to resort to legal action in carrying on the fight against insect pests and plant diseases, for the enforcing of laws sometimes develops into an unpleasant task. I am of the opinion, however, that at this time, in the light of present day knowledge, our laws pertaining to insect and disease control, are very effective weapons, especially when supported by scientific facts, and judiciously administered.

The first law in the State of Missouri, pertaining to insect pest and plant disease control, was enacted in 1913. It referred particularly to nursery stock, and was placed under the direct administration of the Agricultural Experiment Station, with the Department of Entomology in charge of the work. This was probably due to the fact, that previous to 1913, the Department of Entomology, of the Missouri College of Agriculture, had voluntarily inspected for a number of years, the nursery stock of those nurserymen who wanted to make shipments to other states. It was very natural therefore, that the Department of Entomology, of the College of Agriculture, should be asked to carry out the work of the first Plant Act. This first act remained in force until 1925, and did much to improve the situation in Missouri. The one difficulty was, that the Experiment Station disliked to institute legal proceedings against violators, for fear that unfavorable reaction against the Station might possibly result.

In an attempt to remedy this situation the General Assembly in 1925 removed the administration of the Plant Act from the Agricultural Experiment Station and placed it under the control of a State Plant Board, which was composed of three members, the President of the State Board of Agriculture, the Director of the Agriculture Experiment Station and the President of the State Horticultural Society. The

entomologist of the Experiment Station was designated by the amended law as the State Entomologist and Chief Inspector. There was no change in the actual performance of the work. It was still directed by members of the Experiment Station staff, though administered by an independent Board. By this time, however, the regulatory work had become firmly established and was obtaining some support through state appropriations. The agricultural and horticultural interests had come to realize the great importance of the regulatory work.

In the meantime a number of dangerous insect pests and plant diseases had become firmly established in different parts of North America and it was evident that in a short time Missouri would be faced with the problem of combating some of these pests within her own borders. It was, therefore, thought best to place the regulatory work under the administration of the State Board of Agriculture, the official administrative agency of all agricultural regulatory acts in Missouri.

The General Assembly of Missouri, therefore, abolished the State Plant Board and transferred the administration of the Plant Act to the State Board of Agriculture. The transfer became effective August 27, 1929, and the Plant Division of the Missouri State Board of Agriculture was organized a few days later. The chief administrative officer is designated as the State Plant Commissioner with headquarters in the Capitol Building at Jefferson City, Missouri and the Plant Commissioner has complete charge, under the Board, of the inspection and regulatory work.

The Board of Agriculture itself is a bipartisan Board composed of sixteen members, appointed by the Governor, one from each congressional district, besides three ex-officio members. The members of the Board are vitally interested in the agricultural welfare of the state and they take a keen interest in the work which the different Divisions of the Board carries on.

There is every reason to believe that the plant inspection work, as it is now administered, will develop rapidly. The Board has adopted the important policy of employing only men in the Plant Division who have had the necessary technical training to fit them for the work. With the exception of the clerical force every employee of the Plant Division is a graduate of an Agricultural College.

The new Plant Division of the Missouri State Board of Agriculture, is in a position to be of real service to the agricultural and horticultural interest of the State, and its institution may also be significant, in that it marks the resumption of entomological work by the Missouri State Board of Agriculture.

It may be said, therefore, that this substantial state institution, the Missouri State Board of Agriculture, has again, after so many years, assumed the task of assisting Missouri farmers and Missouri fruit growers with not only their insect problems but also with their plant disease problems.

It is fully realized, however, that the work which Riley did in Missouri, can never be surpassed. If the present Plant Division can render only a small per cent of the service as was rendered by Riley, its creation will be fully justified.

CHAIRMAN WALLACE: The next paper is by Messrs. Jones and Boillot.

HOW THE PLANT DIVISION, MISSOURI STATE BOARD OF AGRICULTURE, SERVES THE FRUIT GROWER

By GEORGE D. JONES and B. F. BOILLOT

The Plant Division of the Missouri State Board of Agriculture, though only four months old, has made a serious attempt to be of service to the people of the State, and since this paper is to deal with the services of the Plant Division to the fruit grower, only the functions of the Division pertaining to horticulture will be considered.

These services may be grouped under two more or less distinct types, namely—protective and informative.

The protective services consist of the control of the movement and disposition of plants and plant products, which may serve as a means of disseminating dangerous insect pests and plant diseases. All nursery grown plants legally handled in Missouri, are produced in certified nurseries, sold by certified agents or dealers, and confidently bought by the fruit grower to be visibly free of insect pests and plant diseases. The Plant Division functions as the regulatory body, in that it makes inspections of all nurseries within the State at least once each year, and if necessary, oftener. These nurseries, if found free of dangerous insect pests or plant diseases, they are certified; if found infested or infected, all clean up work is carried on under the supervision of the Plant Division, and no infested or infected stock, is allowed to leave the nursery. All nursery stock which has been subject to infestation, but visibly clean, will be either fumigated or dipped.

It is also the duty of the Plant Division to see that nursery material is handled in no other way, than through certified concerns. There are many dealers in nursery stock who find it more profitable for the time being, not to do some of the things necessary for the prevention of the

spread of insects and diseases. These dealers frequently must be reminded of their duty, which is to handle only certified material, and to keep records of sales and purchases.

The fruit grower is not only protected against infested home grown material, but is as well protected against material grown in other states. Even though the Plant Division at the present time accepts the certificate of inspection of all other states, yet it reserves the right to inspect any shipment at any time as seen fit by the Plant Commissioner. Thus all nursery stock eventually reaching the Missouri fruit grower, is directly under the surveillance of the Plant Division.

Another potential, though not at present active service, is the power which the Board of Agriculture possesses to establish and enforce quarantines against dangerous insect pests and plant diseases. Incidentally three quarantines are in force now; none of them directly affect the fruit grower, still the knowledge, that when necessary, a quarantine will be enacted, creates quite a bit of assurance among the fruit growers, that the Plant Division functions for their protection and service.

The other type of services rendered to the fruit grower, is of an informative nature, not the result of researches, but the results of surveys and observations.

During the past season, nearly 8000 acres of commercial orchards were surveyed. The fruit growers seem to appreciate this service and are pleased to obtain information and assistance in combating any insect pest or plant disease present. During this same survey, the extent and location of the infestation of a new species of apple mining insect, was determined.

A brief bit of history of this apple mining insect carries us back to August of 1928, when an unknown Lepidopterous larva was found to be attacking ripening apples near Waverly, Missouri. The larvae has been identified as belonging to the genus Carposina, a group of small moths; some species of which attacked certain fruits in different parts of the world, particularly the Orient. Adults have not been obtained up to the present time. The insect now for convenience, called "Carposina," was found in thirteen counties variously located in Missouri.

Ten different varieties of apples found to be infested, namely—Grimes, Jonathan, Huntsman, Willow Twig, Minkler, Gano, Ben Davis, Senator, Ingram, and York; named in order of severity of attack. Only recently this insect has been found in the wild haw and wild crab in Missouri. The damage done was found to be quite varied. In some orchards it was scarcely noticeable, while in others as much as 25 per

cent of the picked fruit was found to be infested. It is quite possible that this insect has gone from the wild haw (Cratagus) to the apple. In the Waverly district practically all the wild haws were cut out two years ago. The insect was not noted in apples before this time. Again it may be possible that it is of foreign origin, and the object of determining, at this time, the limits of its distribution in Missouri, is to enable the Plant Division to take any action which may be necessary when the species is definitely determined.

Two other very closely related services may be mentioned: The one is the correspondence service open to any one desiring information concerning any diseases or insects. The other is the issuance of short articles from time to time in various rural editions, giving seasonal hints for the control of some pest of horticultural or agricultural products.

The present organization, even though of only a few months existence, has received commendable co-operation and expressions of approval from the commercial nurserymen and fruit growers of the State.

DR. T. J. HEADLEE: Does this insect infest the fruit in such a way that it can be transported with the shipments of fruit?

MR. B. F. BOILLOT: Yes, it does.

CHAIRMAN WALLACE: The next paper is by L. M. Hutchins.

THE PHONY DISEASE OF THE PEACH

By LEE M. HUTCHINS, *Pathologist, U. S. Peach Disease Field Laboratory, Fort Valley, Ga.*

The first recorded observation of the disorder in peach trees now known as the phony disease was made in the Rumph orchards at Marshallville, Ga., a little more than forty years ago. Only a few trees were then affected and because of their small size in comparison with normal trees of the same age they were at first called "ponies." As the phony trees did not rapidly increase in number they were not at first viewed with alarm. However, they began to be more prevalent and by 1900 an occasional phony tree was seen in the peach districts near Marshallville and Fort Valley. Not until 1915 was the situation regarded as possibly becoming serious, and in that year the late J. H. Hale, whose Fort Valley orchards then numbered 100,000 trees, requested aid from the United States Department of Agriculture. By this time the phony condition in the trees had come to be regarded as a disease and the name "phony disease" had been applied. As a result of Mr. Hale's request, M. B. Waite, Pathologist in Charge of Fruit Disease Investigations, of

the Bureau of Plant Industry, spent several days that summer in the vicinity of Fort Valley studying the disease and making observation- of a general character. Himself a grower on a large commercial scale, and with wide experience in the study of both contagious and physios logical diseases of plants, Dr. Waite was at once aware of the possible menace that this new trouble, which had risen from obscurity to mentionable importance within a few years, might eventually constitute to the peach industry. He previsioned an eradication campaign and at the close of his visit recommended that the orchardists destroy all phony trees as fast as found. Specimen phony trees were dug up and sent to Washington for examination, and the writer, then an assistant in Dr. Waite's laboratory, made cultural tests from the material in an endeavor to find a causal parasitic organism. The same season (1915) Dr. Waite budded normal peach trees with buds from phony trees as a test of communicability. Both the laboratory tests and the field tests gave negative results and it was then realized that a thorough-going series of scientific experiments would be necessary in order to determine the cause of the phony disease.

In 1915 losses due to the disease were only beginning to be felt even in the older orchards. Profits were large in those years and it was natural that the growers should more or less ignore this bizarre new-comer which appeared to actually improve the vigor of the trees it attacked. Few of the growers, indeed, believed it to be a disease, but considered it in the category of a sport, a degeneration of stock, or an overdose of nitrogenous fertilizer; to foresee the great havoc that it was destined to work was of course impossible. The situation was not regarded as a community problem and no concerted effort was then taken to bring it under control. From that time on, however, the disease increased at an alarming rate. Its mounting importance was obscured during 1919 and several succeeding years by a severe outbreak of curculio and brown rot, which caused great wastage of fruit in the orchards, sheds, in transit and at the terminals. Also the peach industry had developed to such an extent that there was a surplus of fruit, and heavy grading-out of the small phony peaches was not as significant as it would otherwise have been. Unfortunately, large quantities of phony fruit found its way to the markets and its effect was reflected in lower prices for the better grades. Conditions improved as far as the curculio and brown rot were concerned, but the inroads of the phony disease came on apace. The dark-green, bushy, phony trees appeared in ever-increasing numbers. The territory of its distribution broadened constantly. New orchards

began to exhibit phony trees, and new counties were invaded. The growers were soon to recognize the importance and subtle work of this most peculiar disease which does not kill, which for a time appears even to stimulate the tree, but which permanently impairs its function of fruit production.

In 1921, with the relocation of a Field Laboratory at Fort Valley for the study of fruit diseases, Dr. Waite incorporated researches on the phony disease as a special project and the writer was assigned to the work as a part of his regular duties. A brief examination made it evident that the cause could not be attributed to an easily discovered parasite. With a long history of peach yellows, rosette, and little peach behind us, one of the obvious experiments was to bud from phony trees to normal trees in order to determine whether the disease might be caused by a germ or virus that was carried in the bud. The latter procedure never fails to transmit any of the above mentioned diseases and a thorough trial was made in the case of the phony disease. Also, the first summer extensive orchard maps were begun in which the occurrence of all phony trees was noted and all new cases were recorded as soon as the characters could be definitely identified. Work was continued along these lines for several seasons and extensive data were taken on the characters of the disease in all parts of the tree at different seasons of the year. None of the budding experiments transmitted the disease and we had failed to open the subject up in any satisfactory manner. Phony trees that had been transplanted remained phony, seeds from phony fruit produced seedlings that were normal in every respect. When phony trees were dug up and replants were put in their places, the replants remained normal except for a certain number, corresponding with the usual incidence for new cases of the disease in the orchard in question. Normal nursery trees planted under the branches of phony trees contracted the disease when their roots were grafted to the roots of the phony tree, but when the graft connection was not made, the nursery trees grew normally except for the few that contracted the disease in the natural way. When the roots of a phony tree were in contact with the roots of a normal tree, the disease was in no case transmitted unless a graft union was made and the two roots were actually united by a growth process. It was thus evident that the disease is not usually, if ever, communicated through the medium of the soil. Nematodes, mycorrhiza and other microscopic soil organisms would appear to be eliminated as possible carriers. Furthermore, extensive surveys show that the disease in Georgia occurs in trees on all soil types and on all

sites. It has been found abundant on washed mountain sides and in fertile valleys, on land newly cleared from the forest and on old cultivated fields.

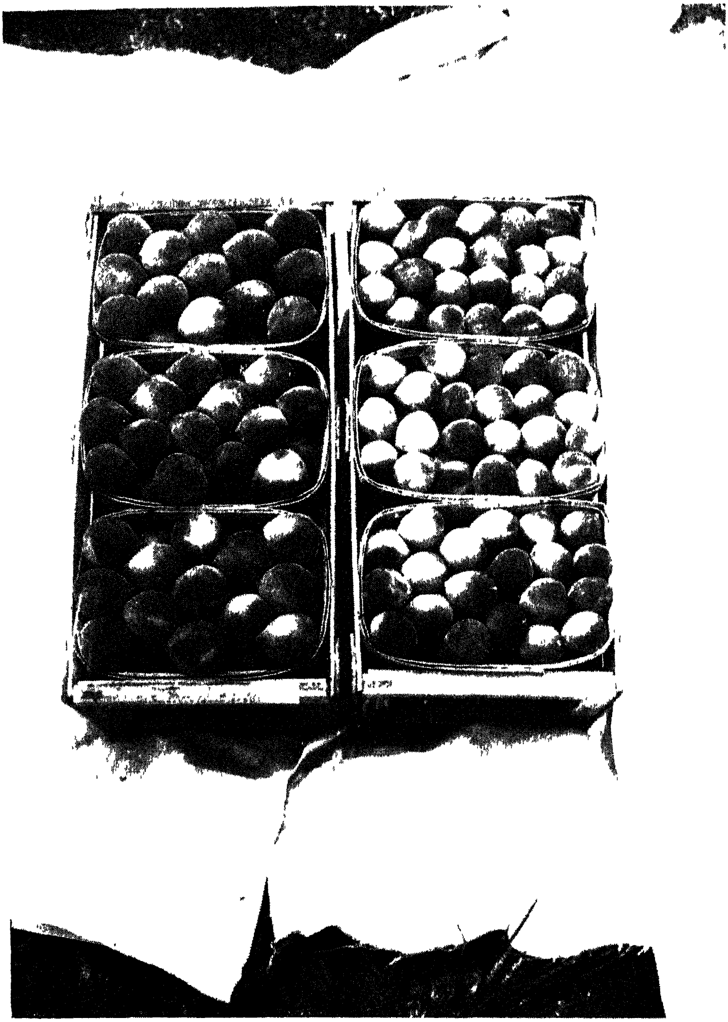
Orchard surveys seemed to indicate that under the most favorable conditions for its appearance a very small percentage of trees did not take the phony disease. When scions or buds were taken from these "resistant" trees and top-worked on phony trees the new shoots that put out were always typical of the disease. This latter behavior was true of scions of other species closely related to the peach, such as almond, apricot and nectarine. On the other hand, when buds or scions from phony trees were top-worked on normal trees the resulting growth was always normal. These and other experiments made it clear that if the supposedly resistant trees were really immune it must be due to a root character and not to any resistance of the shoot, or part of the tree above ground. It was evident that the disease is attributable to a root condition.

In January, 1926, experiments were begun in which pieces of phony roots were grafted to the roots of normal trees in the orchard and in the nursery, and a large number of piece-root grafts were made. The summer of 1926 brought no results. Similar experiments were carried on in January and February, 1927, on a more extensive scale. In August, 1927, a number of orchard trees that had been grafted with roots from phony trees in January 1926, showed unmistakable signs of the phony disease. More evidence was desired in order to draw definite conclusions. In the summer of 1928 results were recorded from experiments performed in January, 1927. These results showed unmistakably that wherever phony roots were used in making piece-root grafts or in grafting on root systems of normal orchard trees, the experimental trees developed typical symptoms of phony disease. The incubation period, or interval between the time the inoculation was performed by the grafting method and the time that the experimental plants showed very definite phony characters, was approximately eighteen months in all of these experiments. All of the check experiments in which normal roots were used remained normal.

At this time it became evident that the phony disease is contagious. Inoculations with the juice expressed from the roots or other parts of phony trees have not communicated the disease under the conditions of our experiments. It has thus far been artificially communicated only by means of grafting a phony root to the root system of the normal tree. This behavior places the disease in the peach yellows group, and

Normal peach tree, Hiley variety, at end of third year's growth in the orchard

Phony peach tree, Hiley variety, at end of third year's growth in the orchard. This tree has just come down with the disease



Hiley peaches. Left, fruits from a normal tree. Right, fruit from a phony tree

the infective principle is now regarded as a virus. However, the phony disease differs from peach yellows in that the virus of phony disease has been found only in the roots of diseased trees and does not appear to enter the shoots above the soil line, while the peach yellows virus invades both shoot and root. This explains why the phony disease is not communicated when buds, scions or seeds from diseased trees are employed.

The phony disease has been wrongly called "collar oedema," the latter term being the name of a physiological disease of peach trees caused by low temperatures that injure but do not kill the tissues about the collar of the tree, the injured growth then swelling and abnormally increasing the diameter of the tree at that point. The word phony is defined "bogus, counterfeit, false." There is no authority for the spelling phoney, as sometimes occurs. The history of the origin and first application of the term "phony disease" is not known, but the disorder was called to the attention of the Department by that name in 1915 and has since come into general use as the official name of the disease.

When plants or animals are diseased, we customarily find the entire individual or parts of the individual showing definite pathological symptoms. The phony disease of the peach presents a remarkable exception to this general rule in that phony trees may have deeper green foliage than normal trees and may in many instances be said to present a healthier appearance. This most unusual character has led to the disease being ignored in small home orchards, in abandoned lots, along road sides and even in commercial orchards where the disease has recently appeared and growers are unfamiliar with it. Until recently growers have not regarded the disease as contagious and have generally given no serious thought to it as a possible menace to the peach industry.

Initial characters of the phony disease do not appear in commercial plantings before the latter part of the second growing season in the orchard, or three seasons from the bud. Thereafter, trees may come down with the disease at any age, and the first symptoms may become evident at any time between May 1 and September 15 of the year that the disease develops.

With the onset of the disease a phony tree develops shortened internodes, a large number of lateral twigs, and large, flattened, dark-green leaves, giving the appearance of compact, dense growth with very healthy foliage. Especially in young trees, decided dwarfing results, and

normal trees quickly exceed phony trees in circumference and height. The annual terminal twig growth of a phony tree may be only from one to six inches, as compared with a terminal growth of one to three feet or more in normal trees. The phony condition may advance the blooming, leafing, and fruit-ripening dates a few days, and it may retard the time of autumn leaf fall. In advanced cases, phony trees may be identified in the dormant condition by the short terminal and the profuse, short, lateral twig growth. In such trees, because of the condensed appearance of the growth, the disease is usually evident at blossoming time and with the first mature leaves in the spring.

Phony trees do not seem to be more subject to winter injuries than are normal trees, and they may live many years after showing the symptoms of the disease. However, since the terminal growth is short, it is difficult to shape the phony trees by pruning to stimulate new growth, and as large limbs die they are not replaced by the tree. After four or five years of the disease the trees are generally ragged and there is apt to be a marked dying back of terminal twigs and branches.

From the first observations of the phony disease at Marshallville, Ga., the disease has spread until at the present time it covers practically all of the commercial peach industry in Georgia and has extended into parts of Alabama and Mississippi. So far as is known this is the only section in the world where the disease occurs. Correspondence and observations in various peach districts of the United States have failed to show any other centers of infection in this country and we are unable to learn of anything like it in other countries. In its area the disease is much less severe in the peach districts at a distance from the locality where it was first found.

The control of the phony disease is now being directed under three distinct classifications. At the Research Laboratory at Fort Valley a study is being made of the various root stocks adapted to top-working to peach, in the hope of finding a good commercial stock that is resistant to the phony disease or its natural carrier.

The United States Department of Agriculture is co-operating with the Georgia State Board of Entomology and the Alabama State Department of Agriculture in an eradication campaign to eliminate the diseased trees from the entire area where it occurs. The campaign is under the general direction of K. F. Kellerman, Associate Chief of the Bureau of Plant Industry, Washington, D. C. William F. Turner is in charge of the eradication work in the field, with headquarters at the U. S. Peach Disease Field Laboratory, Fort Valley, Ga. In the co-operative project,

Manning S. Yeomans, Georgia State Entomologist, and B. P. Livingston, Chief, Division of Plant Industry, of Alabama, represent their respective states. The past summer Mr. Turner had a force of six squads consisting of five men each who visited commercial orchards and either cut down or tagged the phony trees for removal. Mr. Turner states that his force has covered over three-fourths of the commercial trees in Georgia and Alabama and that in September his men inspected approximately five hundred thousand commercial trees per week. The inspectors for this work are selected for general training, experience and adaptability to the work and are given a course of instruction at the U. S. Peach Disease Field Laboratory, Fort Valley, Ga., in which they become familiar with the characters of the disease and its identification in the field in trees of various ages and varieties.

Another feature of the control of the phony disease is Federal Plant Quarantine No. 67, effective June 1, 1929. Under the provisions of this quarantine, shipments of peach nursery trees from the phony disease territory to a territory where the disease does not occur is prohibited when phony trees are known to occur within a distance of one mile of the nurseries.

(For complete information on the quarantine, communicate with Plant Quarantine and Control Administration, United States Department of Agriculture, Washington, D. C.)

It is an established fact that the phony disease is communicable in nature by some means not yet understood and that nursery trees in close proximity to phony trees may contract the disease. As the incubation period of the phony disease is about eighteen months (under the conditions of our experiments), the root system of the nursery tree may become diseased without it being possible to identify the disease in the top growth before shipping time. It is thus possible to disseminate the phony disease by means of nursery stock and for that reason the quarantine is applied. The quarantine does not apply to movement of nursery trees within a quarantined area; that is, a nurseryman even though phony trees may be found within a mile of his nursery may still be permitted to ship his trees to points within the area.

The loss to the peach grower, from the phony disease, consists in fewer fruits from the phony trees and in a decrease in the size of such fruits. The first year that the disease appears in the tops of the trees there is a notable reduction in the average size of the fruit though the number of fruits may not be affected because the fruiting wood was grown in an apparently normal way the year before. With each suc-

ceeding year of the disease in a tree, the crop may become smaller and the average size of the fruit is apt to be smaller until after three or four years of the disease there may be no marketable peaches from the phony trees. Such trees are therefore a liability to the grower as he has the expense of all orchard care and of the occupation of the land, for a non-productive tree. In the territory where the disease was first observed, orchards are on our records in which 99 per cent of the trees were phony at twelve years old. In one case 60 per cent of the trees were phony in an orchard four years old. These young trees were near older orchards in which the percentage of phony trees was large.

It should be remembered that the phony disease cannot be spread by means of phony fruit, seeds, buds or scions. Shipments of fruit containing phony peaches in no way endanger the peach industry of communities through which such shipments may pass or be consumed. No discrimination against peaches from the phony disease area is justifiable, therefore, on the basis that they might possibly introduce or disseminate the phony disease.

Under no conditions has a phony tree ever been observed to recover from the disease. However, the disease does not kill the tree that it attacks. Trees are on our records that have exhibited phony characters for the past eight years and are still living. Roots from these same trees have never failed to communicate the disease to normal trees in root grafting experiments. The longevity of the phony trees, therefore, constitutes a serious problem in the eradication of the disease. Phony door-yard trees may year after year introduce the disease anew into nearby commercial orchards, even though the orchardist himself may practice thorough eradication.

The present well-organized eradication campaign aims, therefore, at biological eradication of the phony disease as the only sure means now known for bringing it under control and preventing an equally disastrous recurrence at some time in the future.

CHAIRMAN WALLACE: Our next paper, and the last one, is by E. N. Cory.

PRACTICABILITY OF THE HOT WATER TREATMENT FOR THE BOXWOOD LEAF MINER[1]

By ERNEST N. CORY and C. GRAHAM, *College Park, Maryland*

ABSTRACT

The practicability of spring treatment of four varieties of the genus Buxus, using hot water at 120° F. for five minutes, has been demonstrated by the treating of 2,430 plants, ranging in size from one to three feet. There was slight temporary injury to tender foliage. The cost, including equipment, was near eight cents per plant.

The boxwood leaf miner has become a pest in a number of states and has been declared, by the Eastern Plant Board, as one of the insects that should be prevented from moving interstate and, therefore, it becomes necessary for regulatory officials to provide a means whereby the infested plants can be successfully treated at a cost that permits the general use of the treatment. Several methods have been used that are fairly successful for the treatment of plants on estates, but are not efficient enough to warrant dependence upon them for purposes of certification of the plants for interstate movement. A method of treatment, using hot water, was worked out by Dr. F. F. Smith of Pennsylvania and details in regard to the method were furnished to the present writers by both Messrs. Smith and Trimble, the latter of the Pennsylvania Department of Agriculture. This method was tried out on rather a large scale in order to determine its effectiveness and its practicability. Fall treatments have not yet been checked.

Nine hundred and thirty heavily infested plants, ranging in size from two to three feet in height, were treated at one nursery and fifteen hundred plants, ranging from one to three feet in height, were treated at another nursery. These were mostly of the variety *Buxus sempervirens*, although some of *B. suffruticosa*, *B. arborescens*, and *B. rotundifolia* were included at one nursery. The conditions in the two nurseries were different, one place being equipped with boilers used for heating the greenhouses, and the other having no such equipment. In fact, the methods used at the two places were slightly different and will be described separately.

At nursery Number 1, five large barrels were placed in a boiler room and temporary hose connections for steam and water run to the barrels. A temperature of 120° F. was maintained without difficulty by stirring the water and running in extra steam from time to time as the thermometer showed a dropping of the temperature. The plants were

[1]*Monarthropalpus buxi* Labou.

brought into the room, inverted in the barrels, and held in place by two 2 x 4 strips. In this way, two to three plants could be suspended in each barrel and seventy-five to one hundred plants could be treated in this way per hour. It was found that it was impractical to burlap the roots, because of the great probability that some twigs would be covered by the burlap and in that way kept out of the hot water. The plants were treated about the middle of April and re-set on the same day that they were treated. Examination one month after for the presence of live larvae failed to show any, and showed the plants for the most part to be in excellent condition. Some tender tips had been killed, but a second inspection in October showed that the plants had survived the treatment and put out new growth. At the same time, an examination was made, plant by plant, for evidences of new injury, but no trace of the midge could be found except the old mined leaves with dead larvae within.

COST OF TREATMENT AT NURSERY NUMBER 1

Number of plants treated	930	
Number of days required for treatment	2	
Number of men per day	7	
Cost of labor		$65.00
Cost of truck		10.00
Total cost of treatment (exclusive of equipment)		75.00
Cost per plant		0.077

At nursery Number 2, since there was no equipment available, the owner purchased a second-hand portable steam engine for $40.00 and with this he heated the water in a trough, which he made himself. This trough was three feet deep, four feet wide, and six feet long. Over the top, strips of 2 x 4 were placed lengthwise and by this means as high as thirty plants could be inverted in the hot water at a single time. These were then loaded on a wagon, at the end of the five minute treatment period, and returned to the field for planting. By this system two hundred and fifty to three hundred plants could be treated per hour. No difficulty was experienced in keeping the water temperature within one degree of the desired 120°.

The treatment was begun on April 24 and the first inspection was made on May 20 for the presence of live larvae and for injury to plants. Apparently no live larvae were present at this inspection and injury to the plants was slight except in one or two cases where the plants had slipped into the tank and were submerged for more than five minutes. Plants were again examined in October for evidence of new injury from the leaf miner, but no such injury was found. The plants had recovered from the treatment and transplanting and were growing well.

Cost of Treatment at Nursery Number 2

Number of plants treated	1500	
Number of days required for treatment	4	
Number of men per day	4	
Cost of labor		$ 40.00
Cost of horse and wagon		12.00
Cost of boiler		40.00
Cost of trough		25.00
Total cost of treatment		117.00
Cost per plant		0.078

Plants should be treated on a cool or cloudy day or else should be protected from the sun until late in the afternoon before being transplanted to the permanent location.

Summarized Data

Total number of plants treated	2,430	
Total cost of treatment including digging and transplanting, but not including permanent equipment		$127.00
Cost per plant		0.052

Summary

The practicability of spring treatment of four varieties of the genus Buxus, using hot water at 120° F. for five minutes, has been demonstrated by the treating of 2,430 plants, ranging in size from one to three feet. Slight temporary injury to tender foliage, but no permanent injury resulted on any of the plants treated correctly. Either temporary equipment, using barrels heated by greenhouse boilers, or the construction of a permanent vat heated from a portable boiler, is satisfactory, and the latter does not increase the cost beyond reason.

Chairman Wallace: Next is the report of the National Plant Board. Dr. W. C. O'Kane will present this report.

Dr. W. C. O'Kane: The National Plant Board report will be as brief as I know how to make it. At the last minute, Mr. McCubbin couldn't be here, and he asked me to report in his place. As you see, I am reporting informally.

I think the National Plant Board is now in its fifth year. It has grown following the growth of some of the constituent boards. The first of the four regional plants was the Western Plant Quarantine Board. I believe that was organized about 1918. Then the Eastern Plant Board, the Central, and the Southern followed.

The status of the National Plant Board is, of course, not that of a body with authority. The status must be understood. It cannot have any possible authority over the regional boards nor over the constituent states, nor can a regional board have real legal authority over its con-

stituent states. Under the organization of the states under the United States constitution that is impossible, but the situation which has arisen in this country in the last ten or fifteen years from the discovery of plant pests in which federal agencies are interested, and in which, also, state agencies are interested has necessitated some form of joint organization. The federal agency, of course, is thoroughly organized. The state agencies cannot be organically brought together. They can be brought together only through some type of voluntary organization in which a board or committee or commission is set up that acts as a sort of spokesman for the several states. That is the ultimate object of the National Plant Board.

As you know, this whole country is divided into four regions, each of which has its regional board. The membership of these boards is drawn from the several states comprising that region, and each of the four regional boards selects two men. Those eight men constitute the National Plant Board. So the National Board, then, stands as spokesman for the states and for the regional boards. That makes possible a sort of highly desirable correlation of understanding between the federal agency and the states.

The need for that correlation is arising continually, and in increasing degree. Those who have been serving on the National Plant Board since it started have seen that continually grow, and it will grow in the future. A given situation arises, a pest appears; control, possible extermination, quarantine measures, and so on, are given consideration. Any of these might be undertaken by federal authorities, or they might be undertaken by state authorities. For a long while we had conflict of those two, or overlapping, or measures that did not fully harmonize. That was natural. One or the other of those two groups, either the federal department or the state concerned, has to handle the situation, or the two work together.

Through the regional boards, and through the National Plant Board, cooperation of that kind, a harmonizing of measures becomes possible. So, during the last four years there have been joint meetings of the National Board with the Plant Quarantine and Control Administration to discuss matters in which both are interested. They wanted to come to an understanding, the final outcome of which either was that the Federal Board would undertake certain measures with reference to a new situation, such as an insect outbreak, or that it would leave the matter to the states. That decision followed discussion between the state men on the one hand, and the federal men on the other.

Personally, I think the possibilities in the future for helpful action on the part of the National Plant Board, as representing the regional boards, is very great. There cannot be too many agencies backing the Florida campaign at the present time.

Not so very long ago I happened to stop in at the office of Chairman Haugen of this state in Washington. In the course of conversation he said to me, "Between us, is there anything to this Mediterranean fruit fly situation?" That was not this fall. That was last spring, but it was after the outbreak had become well recognized, and after the big campaign had started. The reason he asked was because a man of national significance had been in talking to Chairman Haugen and had said, "Well, they have had that thing down there for many years. It is simply a temporary affair, and it will all peter out." I don't mean to say that Chairman Haugen believed that, but at any rate he put that question to me. "Give me the straight on it; does it amount to anything? Give me the lowdown."

You will be certain to find that about everything that arises, and we, ourselves, exhibit the same skepticism about that which we don't know, time and again.

One of the things that the National Plant Board can do is to help to back up federal programs and state programs, and if it accomplishes that it will have accomplished a lot. I look to see that happen more in the future.

The National Board, unfortunately, has lost its valued Chairman, Lee Strong. We had to give him up to be the Chairman of the Federal Board. We are hard up without him. We think theNational Administration is darned lucky to have him.

That is about the only report there is to be made at this time. I merely bespeak your cooperation as individuals, as state individuals, with the National Board and regional boards. None of us can tell what it will accomplish in the future, but I think it can accomplish a lot. (Applause)

CHAIRMAN WALLACE: Next will the reports of Regional Boards. First is the Eastern Plant Board, T. J. Headlee, Chairman. Dr. Headlee is not here just now. We will take the Southern Plant Board, G. M. Bentley.

REPORT OF THE SOUTHERN PLANT BOARD

By G. M. BENTLEY, *Chairman, Knoxville, Tenn.*

The regular meeting of the Southern Plant Board was held at Houston, Texas, Feb. 5, 1929, Prof. R. W. Harned, A. & M. College, Miss., Chairman, W. E. Ander-

son, Baton Rouge, La., vice-chairman; B. P. Livingston, Montgomery, Ala., secretary. Representatives on National Plant Board Dr. Wilmon Newell, Gainesville, Fla. and Mr. R. E. McDonald, Austin, Texas.

The meeting was called to order at the Rice Hotel, Houston, by Chairman R. W. Harned and the following program was rendered:

1. *Roll call by States* showed representatives from the following States: Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, Oklahoma, South Carolina and Texas. North Carolina and Tennessee were not represented. There were also representatives from Arizona and Maryland as well as the Federal Government and the (Texas) State Experiment Station.
2. *Reports of standing committees* were heard.
3. A report was given by the representatives on the National Plant Board.
4. Reading of papers and general discussions of:
    (a) Mexican fruit fly.
    (b) Pink boll worm.
    (c) Argentine ant.
    (d) Sweet potato weevil.
    (e) Sweet potato certification.
    (f) Parcel Post inspection.
    (g) Port inspection.

Mr. P. A. Hoidale, of the Plant Quarantine and Control Administration, Atlanta, Ga., had a splendid paper giving quarantine safeguards being taken on the Texas border in regard to the Mexican Fruit Fly. This paper being of general interest to all southern entomologists it was decided to give this paper the following day before the meeting of the Cotton States Entomologists. This paper is published in the JOURNAL. Mr. B. R. Coad's paper on the Pink boll worm was also held for the entomologists' meeting the following day and is also published in the JOURNAL.

The Argentine ant was discussed by Prof. R. W. Harned. At the close of this discussion a resolution was passed urging the Federal Government to take up the matter of eradication. This resolution was adopted by the Southern Plant Board.

The subject of the Sweet Potato Weevil was assigned to Mr. Tom O'Neill, Austin, Texas, of the State Dept. of Agriculture of Texas.

His paper "Sweet Potato Certification" was discussed in connection with the previous papers by B. P. Livingston, R. W. Harned and M. S. Yeomans.

The Parcel Post Inspection was a subject of much interest and the chief speaker was the Post Master at Houston. He stressed co-operation in the work by the postal authorities and the plant inspection officials. A resolution was offered to have the plant products in parcel post shipments sent immediately to inspectors without waiting for the extra postage, which had meant a considerable delay.

The subject of Port Inspection was entertainingly handled by Oscar Bartlett, of the Arizona State Dept. of Agriculture also by a deputy on border inspection at Hildalgo, Texas. Both of these discussions had special reference to the Border inspection between Mexico and Texas.

At the executive session of the Board G. M. Bentley, Knoxville, Tenn., was elected chairman, B. P. Livingston, Montgomery, Ala., secretary and Prof. R. W. Harned, A. & M. College, Miss., as a representative of National Plant Board for two years.

A special meeting of the Southern Plant Board was held at Atlanta, Ga., May 13th. This meeting was devoted entirely to discussing the Mediterranean Fruit Fly.

Representatives of all the Southern states were present as well as Dr. C. L. Marlatt, P. A. Hoidale and Mr. Kastal of the Plant Quarantine and Control Administration. Dr. C. L. Marlatt gave a detailed account of the fly situation as known at that time, its discovery in Florida having been made April 6th. The precautions to be taken by State officials were emphasized. Methods of examining for the larvae were explained. This was a most instructive meeting at the close of which arrangements were made with state representatives for immediate steps to be taken in their respective States.

Letters to Congressmen have been sent by all the members to their members in Congress in regard to appropriations for the Mediterranean Fruit Fly.

Dr. Wilmon Newell's resignation to the National Plant Board has been presented by himself and to fill his unexpired term Dr. R. W. Leiby, Raleigh, N. C., has been appointed.

The next regular meeting of the Southern Plant Board is set for February 5, 1930, at Jackson, Miss.

CHAIRMAN WALLACE: We should like to have the report of the Central Plant Board, Mr. P. A. Glenn.

REPORT OF THE ANNUAL MEETING OF THE CENTRAL PLANT BOARD FOR THE YEAR ENDING, MARCH, 1929

The fifth annual meeting of the Central Plant Board was held at East Lansing, Michigan, March 1st and 2nd, 1929, with the following States represented: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, Ohio and Wisconsin. The States not represented were Kentucky, North Dakota, and South Dakota.

The most important subject that came up for discussion was the statement of Principles of Quarantine submitted for the action of the Central Plant Board by the National Plant Board through Mr. Geo. A. Dean. The statement of principles was approved, and was considered a valuable piece of constructive work accomplished by the National Plant Board along the line which the National Board is expected to function.

With reference to the entry into this country of commercial shipments of onions infested with the lesser bulb fly, members of the Central Plant Board expressed the opinion that so long as the Plant Quarantine and Control Administration required the treatment of narcissus bulbs infested with the lesser narcissus bulb fly as a condition of interstate movement, it ought not permit the entry into the United States of commercial shipments of onions infested with this pest without treatment. A motion asking the Plant Quarantine and Control Administration to exclude infested onions prevailed.

An interesting and instructive demonstration of the inspection of gladiolus was conducted by Mr. Harry F. Dietz.

The Board discussed the road quarantine for the European Corn Borer and it was the consensus of opinion that the road quarantine should be continued.

The Board was favored by having present Mr. Geo. I. Reeves, who gave an instructive illustrated talk on the alfalfa weevil problem.

We were also favored by Mr. S. B. Fracker who explained methods of conducting transit inspections of plant products passing through the mails, by express and freight.

The officers of the Board were reelected for another year. They are as follows: President, Frank N. Wallace; Secretary-Treasurer, P. A. Glenn; Members of the National Plant Board,—Mr. Geo. A. Dean, 1928–1931, Mr. A. G. Ruggles, 1928–1930.

CHAIRMAN WALLACE: We will next hear the report of the Western Plant Quarantine Board to be given by Mr. A. C. Fleury.

REPORT FOR THE WESTERN PLANT QUARANTINE BOARD—1929

By W. C. JACOBSEN, *Secretary State Department of Agriculture, Sacramento, California*

INTRODUCTORY

Consideration of the difficulties attending enforcement never seem to be lacking whenever a group of plant quarantine officials meet. In the main, these difficulties seem to arise from a lack of information on the part of the general public or on the part of agents of transportation companies not fully familiar with the purposes and value of quarantine in stemming pest invasion, nor with the heavy expense which can be levied on an agricultural industry to control pests. Sometimes it is because of indifference, or frequently because there is some inconvenience attached to the observance of quarantine requirements. Inconvenience, of course, is a necessary evil in connection with all law enforcement work, and the patience of the average Mr. Citizen does not incline to very great tolerance when the inconvenience is caused because of a danger from bugs. His conception of the effects of serious pests in every-day business is not very active.

However, do we not, as quarantine enforcement officers, endeavor to carry more than is necessary of the burden of defending some of the things that we are charged with a responsibility of doing? The protection against pest losses afforded the agricultural industry, and indirectly to other business, by quarantine enactments and their enforcement is too frequently misunderstood even by the people to whom they are of greatest value. Perhaps we could sponsor a more intensive attempt at educational work to give them a broader insight into the purposes and value of plant quarantine and nursery inspection and make them parties to many of the discussions which, at the present time, are confined almost exclusively to officials. Growers and farmers could be made to feel that they are real participants in consideration of measures relative to pest prevention. Our experience in the Western Plant Quarantine Board has been, that whenever they have participated each has turned out to be a missionary preaching the gospel of adequate inspection and proper quarantine enforcement, frequently in a better fashion than those technically engaged in the work. In California we have a great number of farmers who are fully "quarantine conscious," if that be a proper term.

Early in the history of our Western Board, the transportation agencies were made an integral party of our organization, and as a result there has been not only full understanding of the importance of quarantine but a spirit of cooperation developed which has stood us in excellent stead many times. Therefore, wherever possible, growers and trasportation representatives should be invited to attend quarantine and inspection conferences and every opportunity taken to present more detailed information as to our purpose regardless of whether or not they might be directly concerned at the time. Sooner or later every farmer feels the effects of agricultural regulatory work, of which plant quarantine is a highly important part.

Some do attend now with special requests, either to have a particular burden relieved or to attempt to gain an advantage, but these are purely incidental to our thought here. Such people frequently develop a changed viewpoint and generally obtain a far better understanding of quarantine whys and wherefores.

There is opposition occasioned by people who are inherently out of sympathy with quarantine enforcement, often conscientiously. They will hardly deny the importance or necessity of pest control, yet they completely overlook the fact that quarantine enforcement is a real phase of pest control being exercised as a prophylactic measure.

After all, quarantine is the primary phase of pest control, representing inspection vigilance and organization before pest establishment rather than after. Seldom can numbers of pests be dealt with so advantageously with the same organization as is the case with quarantine, and at a far less expense than actual field pest control campaigns against a single insect or disease after their establishment. The agricultural industry should be encouraged to really voice its sentiments. They would then understand that quarantine, as a primary pest control measure, is more advantageous than the individual burden of pest control expense. Growers' organizations should voice themselves to a far greater extent than they do in supporting plant quarantine, but they must learn of its precepts before this is possible and, undoubtedly, it is among our responsibilities to offer assistance in this connection. The trend toward making quarantine knowledge a matter of wider information does appear more evident in the Western Plant Quarantine Board.

Work of the Board

Most important of all matters coming to the attention of the Western Plant Quarantine Board was the finding of Mediterranean fruit fly within the United States. An informal meeting of the Board was held at Sacramento early in May, at which time the members present pledged their full support to the eradication program which had been undertaken, expressed full confidence in the leaders in that campaign, requested such action to be taken by the Plant Quarantine and Control Administration as would insure against spread of fruit fly into western and southern areas where host fruits of fruit fly were being grown under climatic conditions undoubtedly favorable to its establishment, and emphasized again the importance of additional federal quarantine inspection at maritime ports and at border points of entry.

As a result of this meeting, there was a co-ordinated opinion among the western states which was carried forward to the regular annual meeting of the Board at Salt Lake City, Utah, in July.

At that time the resolutions of the informal Sacramento meeting were reaffirmed, and, besides, the members pledged to aid in whatever ways possible to support requests for necessary finances to carry this campaign to a successful conclusion.

Especial consideration was given to the possibility of trans-shipment of host fruits of fruit fly from sections into which shipments might move directly from the quarantined area in Florida. This condition has since been greatly helped by the development of heat treatment and close supervision of certification of host fruit and vegetable shipments moving out of Florida.

It was agreed that it would be desirable for the western states to undertake, insofar as possible, more intensive surveys of the fruit and vegetable growing districts under their jurisdiction to determine if, by chance, any fruit fly infestation has become established from host fruits shipped in before the federal quarantine was in force.

This was coupled with the agreement that quarantine enforcement would be intensified insofar as possible under the limited funds and personnel available, and thus to encounter violations of federal quarantine No. 68.

Augmented finances for additional federal port and border inspection were again given serious consideration, and it was agreed to fully support all requests for this additional service when this subject came before Congress in connection with the budget for the Plant Quarantine and Control Administration, it being recognized that while a partial inspection is a helpful deterrent to the introduction of injurious pests and diseases, yet, until all ports and border points are fully covered, there will always be some appreciable hazard, especially at ports not guarded and through which an occasional lot of infested plant material might find its way.

Representation has been made to members of Congress by the individual members of the Board, not only in connection with this subject, but they have consistently kept before their members of Congress the importance of obtaining necessary finances with which to further support and carry on the Mediterranean fruit fly work.

Larch canker was considered a very potential menace to the vast acreages of valuable lumber timber, including Douglas fir and western yellow pine species, both of which seem to be susceptible. The U. S. Plant Quarantine and Control Administration was petitioned to take necessary additional steps to provide for adequate scouting of possible areas of larch canker infection, and to place in effect restrictions to prevent introduction into new areas. Reports from the office of Forest Pathology, U. S. Bureau of Plant Industry, indicate that all known infestations are being eradicated as rapidly as they are being found.

Certain matters were referred to the National Plant Board for consideration, especially to bring about the discontinuance of shipments from Argentina and Porto Rico of dangerous pest hosts to northern Atlantic sea-ports, because of the danger of their reshipment after arrival into states having crops susceptible to some of the pests they might carry.

The National Plant Board was requested to develop a sound publicity program for the purpose of disseminating fact-based information on the purposes of plant quarantine, diverting this information into journals of national and agricultural circulation to counteract the unfavorable consideration that is being given to items prepared by those opposing plant quarantines. Frequently, those who are in disagreement with plant quarantine have suggested an investigation of the effects of quarantine, the tenor of such suggestions indicating that quarantine is detrimental, whereas, actually a full investigation of the subject of plant quarantine would unquestionably reveal the reverse to be true. Proper information in magazines would help.

The National Plant Board was further requested to follow closely all developments in connection with the Mediterranean fruit fly campaign, especially insofar as modifications in federal quarantine No. 68 were concerned.

The special items for consideration and for which active committees were appointed or continued were as follows:

(1) WEED CONTROL. It was recognized that some states do not conduct any systematic weed control investigations but that frequently when such investigations are being undertaken they are duplicated because of lack of knowledge of what is being carried on in other sections of the United States. Therefore, a request was made of the U. S. Department of Agriculture that it centralize all of its weed control investigations under one head or division so that there would be one point of contact

in Washington for all weed control information and thus give the several states an opportunity to cooperate under the leadership of one consistent federal organization. Now, it is necessary to contact a wide variety of bureaus and divisions, some of which were engaged in observations on weed control only in a limited field to meet their immediate needs. The ability of weeds to harbor pests over periods when crops are not in evidence or dormant and their capacity to serve as intermediate hosts of injurious insects and plant diseases, has led to more intensive consideration of the weed control problem.

(2) APIARY INSPECTION. The Western Plant Quarantine Board undertook as early as 1924 to give consideration to a uniform plan of handling apiary inspection quarantines and disease control measures as between the eleven western states. The net result over a period of years has been the appointment of a permanent apiary inspection committee with a project of work outlined. The primary considerations involved are the development of a reliable system of certification for movements of bees and apiary equipment as between states, also the adoption of burning as a method for American foul brood eradication.

(3) ALFALFA MEAL. One of the projects of major importance for the Western Plant Quarantine Board is an investigation as to the pest hazards involved in the movement of alfalfa meal from the angle of enhancing the spread of alfalfa weevil. This Board was responsible for and approved the investigations made a number of years ago which brought about quarantine modifications to permit the movement of alfalfa meal from alfalfa weevil infested territories during the winter season under proper safeguards. Further investigations were considered necessary to determine whether the movement of alfalfa meal the year around could be made safe.

The Board was responsible for obtaining $5000.00 for the U. S. Bureau of Entomology and resulting investigations by the Bureau Laboratory at Salt Lake City indicated that equipment between the sacking room in the alfalfa meal mill and the railroad car would be the essential to prevent any contamination of the meal after it had come through the milling process. The milling process itself proved satisfactory as a means of destroying any possible infestation.

The Alfalfa Meal Committee of the Western Plant Quarantine Board has had several informal conferences, one as recent as September 10, 1929, at which time they approved plans for a mechanical device for guarding against contamination at car door. These plans have been submitted to all of the member states and now await their ratification before adoption. If approved, steps will then be taken to modify the quarantine regulations of the several states in order to permit movement of meal the year around.

GENERAL MATTERS

Ever since it became apparent that funds for continuing the eradication campaign against Mediterranean fruit fly were running low, the members of the Western Plant Quarantine Board have consistently sought the aid of our Congressmen in supporting adequate appropriations to carry this work on to a successful conclusion. The results obtained in Florida, under the direction of the Plant Quarantine and Control Administration and Dr. Wilmon Newell, have been such that there is every hope that eradication can be accomplished. The necessities therefor indicate that unless adequate finances are available, much valuable work will have to be discontinued and the accomplishments to date will receive a serious setback. Every state in the

United States should lend their support to this project regardless of their crops. Other serious pests may find an entrance into their territory.

Three states of the Western Plant Quarantine Board recently attended the 62d Fruit Growers and Farmers Convention at Sacramento in December, 1929, at which time they were interested participants in consideration of matters pertaining to adequate support of plant quarantine and in connection with matters having to do with the Mediterranean fruit fly campaign. The member states of the Western Plant Quarantine Board have, ever since its organization, worked in the closest harmony. There have been occasional disagreements as to policies and procedure but these have been ironed out with proper satisfaction when submitted in conference.

CHAIRMAN WALLACE: We will have the report of the Eastern Plant Board by Professor T. J. Headlee.

REPORT OF THE EASTERN PLANT BOARD FOR THE YEAR 1929

During the year 1929 the operation of various plant quarantines of inter-state and intra-state character has claimed most of the attention of the Eastern Plant Board. This statement does not mean that the board has lost interest in the problem of simplifying and improving the operation of ordinary plant infesting insect control activities, but rather that plant quarantine matters have forced themselves into the foreground by the effect they are having upon legitimate business interests.

Speaking in general it has seemed to us that quarantines have laid a heavy charge upon our people for the benefit of other portions of the United States, in spite of the fact our people are in no wise to blame for the appearance of certain insects in our territory first. With present practice, this charge is paid by individuals, firms, and corporations, which at the same time are also called upon to contribute their share of federal taxes. Furthermore, the people of each state are taxed to contribute state money to the operation of certain of these quarantines. It should be pointed that the individual, firms, or corporations doing a plant business may and sometimes is compelled to finance certain operations of his or its business solely to conform to quarantine requirements, to pay taxes to the state part of which is used to operate the to him decidedly injurious quarantine, and to pay taxes to the federal government part of which is also used to operate the to him injurious quarantine.

The American business man is really extraordinarily patient in the face of such conditions as outlined above and so long as he can conform and keep his business going he will do so with a minimum amount of grumbling, but where the restrictive measures reach a point where he can foresee not only sharp curtailment of his business but its quite possible destruction, his reaction is bound to be as vigorous as he can make it and he is certain to carry it too far if his efforts meet with success.

The Eastern Plant Board has been brought into sharp contact with the business man's reaction to certain plant quarantines now in force in the eastern district and has been made to feel that they constitute a very real problem, a fair and equitable solution for which is urgently needed. Of course, the prominence of this problem is not a matter of one year's growth nor is the board's knowledge of it a matter of very recent occurrence. The year 1929 simply represents the highest point as yet reached by the reactions. That point has, however, been sufficiently high to force itself into the foreground of the Board's thought.

The Eastern Plant Board has adopted the statement of quarantine principles, submitted to it by the National Plant Board, with only very minor changes, because it felt that this statement represented a fundamental step in the right direction. Drawing upon its first hand experience with plant quarantines it adopted the following resolution at its last annual meeting.

"When an insect, new to or not heretofore widely distributed within the United States, has become established immediate investigation and suppressive measures should be prosecuted vigorously, coupled with such practicable quarantine measures as offer the best hope for the prevention of spread."

"If and when it has been determined that the pest has not been eradicated or suppressed and has been further distributed, the principal efforts of the responsible Federal and state officials should be directed towards research designed to develop the most effective control measures. Coupled with the research program, quarantine measures designed to guard against the establishment at long distances from the original locus should be the principal or only effort at regulation."

This resolution is designed to reduce quarantine procedure to the minimum which will afford all the really practicable protection and to emphasize the need for immediate, constant, and swift research to form an adequate basis for each necessary restrictive step.

It was thought that the more basic matters were covered by the statement of quarantine principles above referred to.

It is felt by the Eastern Plant Board that plant quarantine matters have reached a point in the eastern district where they constitute a distinct and dangerous problem, a satisfactory solution for which is most urgently needed. Up to the present time this board has taken no formal action, other than adopting the statement of quarantine principles and the passage, of certain resolutions, the chief of which has been quoted in this report, looking toward the solution of this problem.

CHAIRMAN WALLACE: We will next have the report of the Resolutions Committee.

REPORT OF THE COMMITTEE ON RESOLUTIONS, SECTION OF PLANT QUARANTINE AND INSPECTION, AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

WHEREAS: The eradication of the Mediterranean Fruit Fly is of paramount importance to the southern and western fruit and vegetable producing sections of the United States, as well as the consuming public of the entire United States and Canada, and

WHEREAS: The eradication campaign so efficiently and successfully iuagurated and conducted by the state of Florida and the United States Department of Agriculture co-operating, has accomplished such remarkable results and should be continued to a successful conclusion.

Therefore Be It Resolved: That the Section of Plant Quarantine and Inspection at the 42nd Annual Meeting of the American Association of Economic Entomologists at Des Moines, Iowa, December 30th, 1929, endorse and support the continuation of the eradication program, and recommend that the National Plant Board take such steps as they deem advisable in the way of securing support from Congress for adequate funds to eradicate this pest.

GEORGE A. DEAN, *Chairman*,
A. C. FLEURY,
K. C. SULLIVAN, *Committee*.

The motion was put to a vote and carried.

MR. MONTGOMERY: I move that the officers of this Section be instructed to supply a copy of that resolution to the Secretary of Agriculture, to the Chairmen of the Committees on Appropriations of the United States Senate and the House of Representatives; to the National Plant Board, and to the Secretary of the Association.

CHAIRMAN WALLACE: I don't know that we need to vote on that. We will see that it is done.

We will now have the report of the Nominations Committee.

REPORT OF THE COMMITTEE ON NOMINATIONS

The Committee on Nominations recommends as officers of this section for the next year the following: Chairman, Professor E. N. Cory, College Park, Maryland; Secretary, Dr. S. B. Fracker of the U. S. Dept. of Agri., Washington, D. C.

Respectfully submitted,
L. S. MCLAINE
P. A. GLENN
R. W. HARNED, *Chairman*

DR. HEADLEE: I move the adoption of the report and the election of the officers.

The motion was put to a vote and carried.

CHAIRMAN WALLACE: Is there any other business to come before the meeting?

I neglected to ask for any discussion on the reports of the regional boards. If there was any, we could take it up now.

Is there any other business to come before this meeting? If not, we will stand adjourned.

The meeting adjourned at six-ten o'clock.

SUMMARY OF RESULTS OBTAINED WITH TRAP BAITS IN CAPTURING THE CODLING MOTH IN 1927

By M. A. YOTHERS, *Associate Entomologist, Bureau of Entomology, Yakima, Wash.*

ABSTRACT

This paper is a progress report[1] upon the use of attractive baits for capturing the codling moth, *Carpocapsa pomonella* L. Comparisons are made of several kinds of baits in which a total of 17,738 codling moths were captured. Considerable control is evidenced as a result of the experiments made in one orchard although the primary purpose of the experiments was to determine the relative attractiveness of various baits. The relation of temperature fluctuations to flight activity of the moths is presented in graphs, which indicate that there is a very intimate correlation between the two.

[1]Yothers, M. A. Summary of Three Years' Tests of Trap Baits for Capturing the Codling Moth. Journ. Econ. Ent. 20, p. 567, 1927.

THE J. H. WRIGHT ORCHARD (Table 1 and Fig. 51). The test in the J. H. Wright orchard was planned primarily for the purpose of determining the control value against the codling moth of the use of trap baits, supplementing a regular spraying program and continued throughout the season. A block of 100 large Rome Beauty trees was used. This block was surrounded on the north, west, and south by other parts of the same orchard. Bait, consisting of molasses approximately 1–10 to 1–15 dilution, was used in 1½-quart enameled pans suspended in the upper

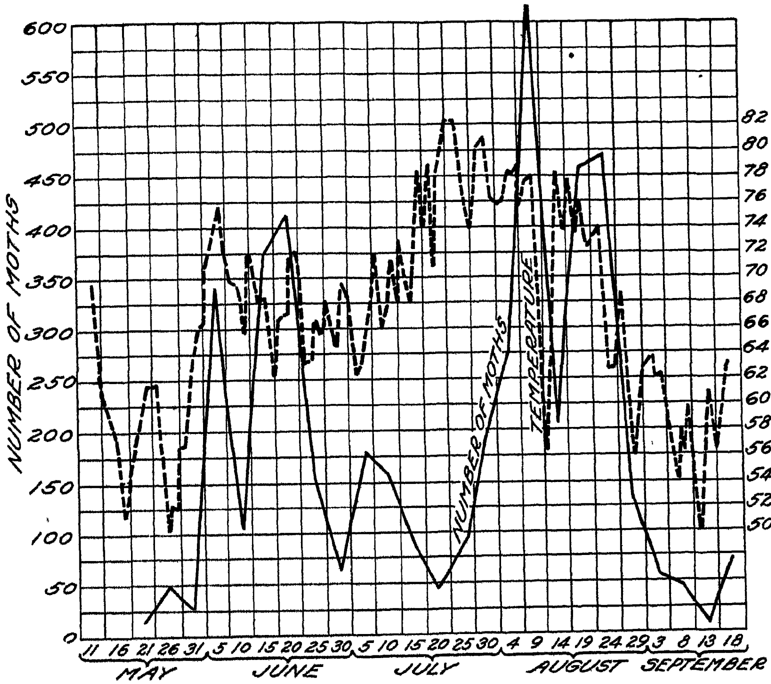


FIG. 51.—The effect of temperature upon the flight activity of the codling moth as indicated by the number of moths captured in trap baits in the J. H. Wright Orchard, Yakima, Wash., 1927.

third of each tree top. Baiting was started May 16, replenishments made every five days, and the test terminated September 18. In all 4,611 codling moths were captured. Spring-brood moths were caught from May 16 to sometime in early July, although most of them were captured in June. First and second brood moths were caught from about the middle of July to the end of the season, most of them, however, during August. In this test, as in another in a different orchard,

there was a considerable increase in the number of moths caught in the middle of what one would expect to be the low period between broods. This also checks with a similar condition in 1926.

Table 1. Number of Codling Moths Captured With Trap Baits in Tests in Three Orchards, Yakima, Wash., 1927

C. H. Hinman orchard Maximum, 60 bait pans		J. H. Wright orchard 100 bait pans		West Broadway orchard 56 bait pans	
Date	Number of codling moths captured	Date	Number of codling moths captured	Date	Number of codling moths captured
May 5	0	May 21	12	July 28	199
7	0	26	50	30	264
9	0	31	26	Aug. 1	599
10	0	June 5	332	3	419
11	0	10	108	5	995
14	16	15	370	7	965
17	129	20	413	9	921
20	2	25	154	11	678
23	2	30	68	13	11
26	9	July 5	180	15	422
29	3	10	166	17	515
June 1	78	15	89	19	485
4	334	20	40	21	492
7	194	25	88	23	489
10	56	30	192	25	93
13	79	Aug. 4	273	27	56
16	220	9	611	29	40
19	191	14	208	31	10
22	147	19	459	Sept. 2	55
25	37	24	470	4	15
28	14	29	129	6	56
July 1	24	Sept. 3	52	8	0
4	41	8	46	10	2
7	48	13	5		
10	59	18	70		
13	34				
16	23				
19	42				
22	26				
25	40				
28	79				
31	183				
Aug. 3	156				
6	568				
9	503				
12	200				
15	214				
18	637				
21	597				
24	208				
27	64				
30	25				
Sept. 2	24				
5	32				
8	7				
11	1				
Total	5,346		4,611		7,781
Grand total					17,738

Unfortunately, owing to an extremely light crop in the baited plat, no control was evidenced by this use of the baits throughout the season, although there were certain indications of some value, as follows: In the unbaited plat there were over four times as many calyx-wormy fruits as there were in the baited plat, over one-third more side-wormy fruits, and a third more apples which had been entered by more than one worm each, although in this plat there was 50 per cent more fruit and the trees were much smaller. While the crop on the smaller, unbaited trees was light to fair, that on the large, baited trees was extremely light—from half a box to 5 or 6 boxes to the tree where there should have been, in a normal crop, 15 to 20 boxes. This shows that no valid comparisons can be drawn between the results in the baited and unbaited blocks.

THE C. H. HINMAN ORCHARD (Table 2 and Fig. 52). The bait experiments in the C. H. Hinman orchard consisted largely of tests with various kinds of baits, comparison being made especially between different kinds and proportions of molasses. Tests were also made with apple-ferment bait and with baits on poles on a level with the tops of the trees compared with baits in pans hung within the upper third of the tree tops. In all, 5,346 codling moths were captured from May 11 to September 10. Spring-brood moths were captured from May 11 to the end of June. First and second brood moths were captured from late July to September 11. Nearly all of these were caught during August. Baits, this time, were in operation before any moths had emerged, as none were caught on the nights of May 4 to 9 in a brown-sugar ferment, and none on the night of May 10 in 6 pans of molasses-ferment bait. At the expiration of four more nights, May 10 to 13 inclusive, 15 moths were caught, and during the next three nights 83 were caught. Apparently the increasing temperature of May 13 started emergence of the moths, and the greatly increased temperature of the 14th, 15th, and 16th brought them out in considerable numbers.

In the comparison of baits in this orchard, the following points were brought out:

TEST *B. 1, 2.* In a comparison of 3 pans of a light golden colored molasses with 3 pans of high-grade medium dark table molasses, the pans having been used over a period of 25 days from May 10 to June 4, the light molasses caught 160 codling moths against 31 for the medium dark molasses.

TEST *B. 3, 4.* This was another test of the two foregoing materials except that the medium dark molasses had double the quantity of yeast in it. The pans were operated only 9 days, and caught only 11 moths, 8 of which were in the light molasses.

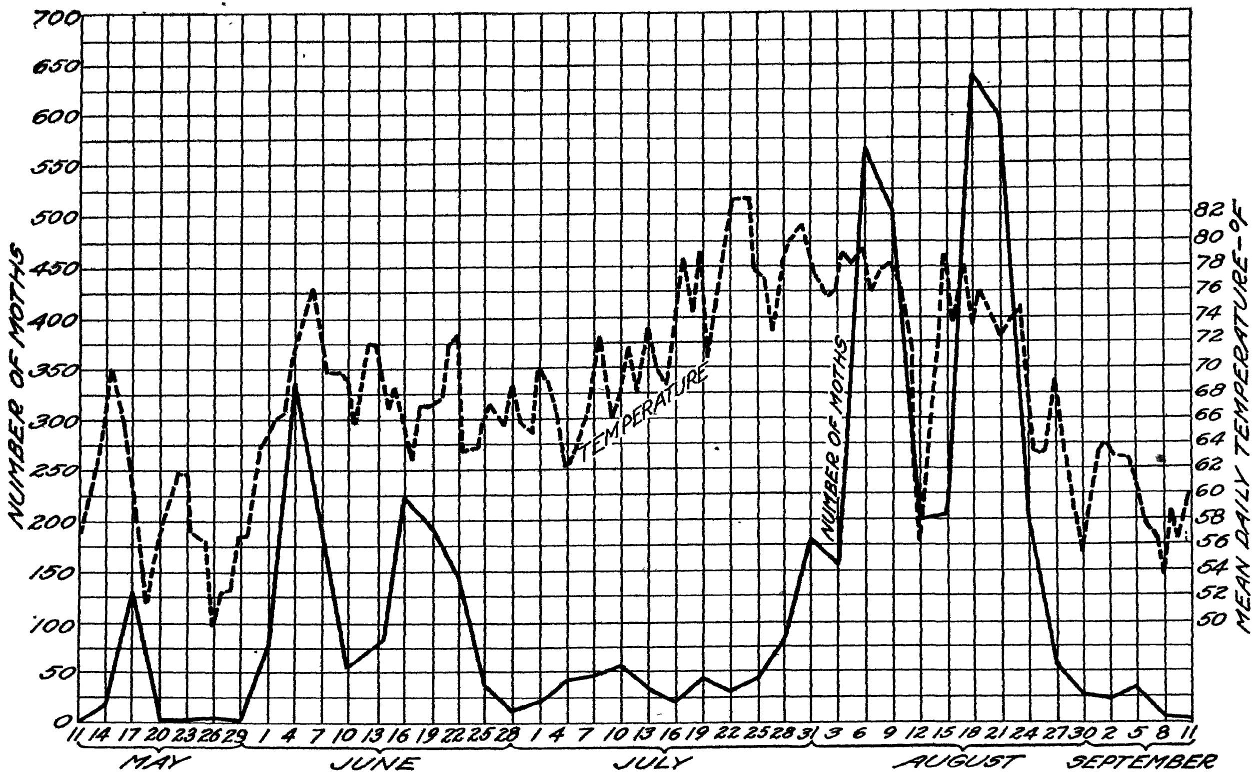


Fig. 52.—The effect of temperature upon the flight activity of the codling moth as indicated by the number of moths-captured in trap baits in the C. H. Hinman Orchard, Yakima, Wash., 1927.

TABLE 2. NUMBER OF CODLING MOTHS CAPTURED IN TRAP BAITS, C. H. HINMAN ORCHARD, YAKIMA, WASH., 1927

Test	Material	Dilution	Number of moths captured	Date started	Date finished	Number of days	Number of pans	Average number of moths per pan per day
A	Brown sugar and water	1–10	0	May 4	May 10	6	5	——
B¹	Light golden molasses	1–10	160	10	June 4	25	3	2.13
B²	Medium dark molasses	1–10	31	10	4	25	3	.41
B³	Light golden molasses	1– 8	8	June 4	13	9	3	.30
B⁴	Medium dark molasses, double amt. of yeast	1–10	3	4	13	9	3	.11
C¹	Medium dark molasses	1–10	906	May 10	Sept. 11	124	5	1.46
C²	Medium dark molasses	1–20	708	10	11	124	5	1.14
D	Medium dark molasses	1–10	462	29	11	105	5	.88
E	Apple ferment	——	327	29	11	105	5	.62
*F¹	Apple ferment	——	50	June 1	July 19	48	2	.52
*F²	Medium dark molasses	1–10	77	1	19	48	2	.80
G¹	Medium dark molasses on poles—replenished	1–10	158	4	22	48	5	.66
G²	Medium dark molasses on poles—water only added	1–10	102	4	22	48	5	.43
H¹	Medium dark molasses	1–10	389	13	Sept. 11	90	3	1.44
H²	Medium dark molasses. No yeast	1–10	299	13	11	90	3	1.11
**I	Apple ferment and medium dark molasses together	1–10	438	13	11	90	5	.97
J	Medium dark molasses	1–10	180	13	11	90	5	.40
K	Medium dark molasses	1–20	93	13	11	90	5	.21
L	Medium dark molasses	1–10	192	13	11	90	5	.43
M¹	Medium dark molasses on poles	1–20	288	July 22	11	51	5	1.13
M²	Special dark, heavy molasses on poles	1–20	475	22	11	51	5	1.86

*These four kettles in a single tree.

**One part molasses to 10 parts of apple ferment.

Test *C*. This was a comparison of medium dark molasses 1–10 with the same molasses 1–20, operated throughout the entire season on the outside west row of the orchard. In the 124 days the 1–10 dilution caught 906 moths and the 1–20 caught 708. This difference itself might not be held significant were it not confirmed by other tests in this and another orchard. Probably the dilution of thi grade of molasses is less attractive at 1 to 20 than at 1 to 10.

Tests *D* and *E*. A comparison of apple-fe ent bait with medium dark molasses 1–10 for 105 days from May 29 t September 11, 5 pans being used for each, showed 462 moths caught in the molasses and 327 in the apple bait, an average of 0.88 for the molasses and 0.62 for the apple bait. Again the difference between these might not be of much importance were it not for verification in the following test, for example.

Test *F*. In this test 2 pans each of molasses an apple ferment were hung approximately equally distant apart in a sing large tree. These were operated for 48 days from June 1 to July 19. he molasses (1–10) caught 77 moths and the apple bait 50, an average of .80 for the molasses and 0.52 for the apple.

Test *G*. A comparison of bait pans in which the lasses 1–10 was replenished each time of examination with molasses 1–, and bait pans in which the bait was replenished with water only s wed that the regularly replenished molasses caught 158 moths wl water-replenished baits caught 102.

Test *H*. In a comparison of 3 bait pans in which the ses bait 1–10 was replenished with the same bait containing yeast an bait pans in which the bait was replenished with molasses 1–10 containing no yeast, it was found that the yeast made the bait more attractive. The bait with yeast captured 389 moths whereas the molasses wi yeast caught only 299. There would have been a greater differenc had not yeast got into the non-yeasted pans through natural a through being carried over accidentally on the strainer used fo g out the insects. It was not determined whether or not the yea the non-yeasted pans was the same yeast as that used in the othe pans. This test ran for 90 days with 3 pans each.

Tests *I*, *J*, *K*, *L*. In these comparable plats comparison was made of the following: Molasses, 1 part to 10 parts of apple ferment without sugar; molasses 1–10; molasses 1–20; and molasses 1–10 with no yeast. These were operated for 90 days in 5 pans each in parallel adjoining rows. The molasses-apple ferment bait caught an average of 0.97 moth per pan per day, the molasses 1–10 caught an average of 0.40, the molasses

1–20 caught an average of 0.21, and the fourth row, with no yeast, caught an average of 0.43.

Here again it is not possible to tell how much of the difference is due to relative value of the materials and how much should be charged to position of the baits with regard to the others. The first row, and by far the most effective bait, judging by results, was probably in a much more advantageous situation than the others. The second and third were less favorably situated, and the fourth again was in a more favorable position on account of th rger number of unbaited trees from which to attract moths.

TEST *M*. A compariso was made of the medium dark molasses 1–20 with a special grade of very dark, heavy molasses also 1–20. Both of these were on poles 51 days, and 5 pans of each bait were used. The dark, heavy molasses caught 475 moths and the medium dark caught 288; an average of 1.86 for the special and 1.13 for the other. Since each of these had about the ame number of trees from which to draw moths they should be fairly mparable.

CONTROL VALUE O. TRAP BAITS IN HINMAN ORCHARD. It was not intended that these baits should be of any particular control value for the codling moth in the Winesap block of this orchard where the bait tests were made, as there were only 60 pans operating, at the maximum, in about twice that many trees, with no attention to distribution for control. However, over 5,000 codling moths were captured and the fruit at picking time was practically free of worms and stings—probably not more than a fraction of 1 per cent of both combined. The unusual control may have been due to the spraying program, consisting of two applications of lead arsenate alone and three applications of lead arsenate with the addition of a summer oil, added for San Jose scale control. In the Rome Beauty block (a variety, however, which is supposed to be more susceptible to codling moth infestation) the injury was probably several per cent for both worms and stings. No baits were used in the Rome Beauty tract. Also a considerable number of Rome Beauty trees nearest the baits in the Winesap block, and 6 in some old trees separating the two blocks, were very much more free of larvae under the bands than elsewhere in the Rome block. Apparently the bait traps attracted the moths for 3 or 4 tree rows outside of the baited area.

WEST BROADWAY ORCHARD (Table 3 and Fig. 53). In these experiments duplicate tests were run in approximately alternate trees, with baits upon poles at the level of the tops of the trees in comparison with similar baits hung in the upper third of the tree tops. In all nine cases,

except one, the pans on the poles captured more moths than those in the tree tops. The single exception is accounted for by the poor trees and the falling of certain poles. Evidently it is very well verified now that more moths are captured at the top of the trees than down in the tree tops.

All of the tests in this series are fairly comparable, except that those starting first (July 23) have a little bit the disadvantage since at this time moths were not emerging in as great numbers as they were on

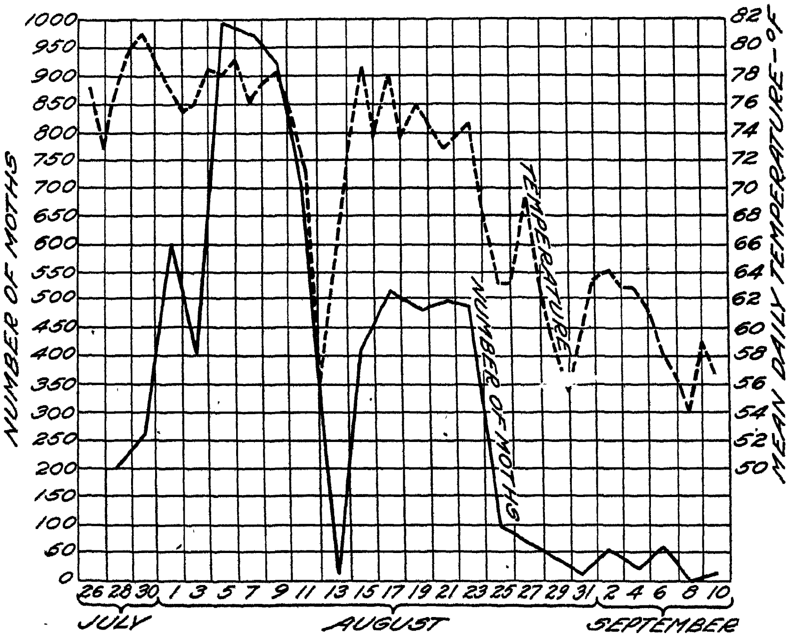


Fig. 53.—The effect of temperature upon the flight activity of the codling moth as indicated by the number of moths captured in trap baits in the West Broadway Orchard, Yakima, Wash., 1927.

July 28 and August 3, when the other tests were begun. However, this disadvantage does not influence greatly the final results.

In these experiments it is indicated that the medium dark molasses 1–10 on poles was the best material, averaging 5.41 moths per pan per day. The next best was the apple bait on poles, averaging 3.80. The stock-feeding molasses did not show much value compared with the other grades.

TABLE 3. NUMBER OF CODLING MOTHS CAPTURED IN TRAP BAITS, WEST BROADWAY ORCHARD, YAKIMA, WASH., 1927

Test	Material	Dilution	Position of pans	Number of moths captured	Date started	Date finished	Number of days	Number of pans	Average number of moths per pan per day Separately	Average number of moths per pan per day Together
A	Apple ferment..................	——	In trees	495	July 23	Sept. 10	49	3	3.37	3.58
			On poles	558	23	10	49	3	3.80	
B	Medium dark molasses.........	1–20	In trees	381	23	10	49	3	2.59	3.09
			On poles	527	23	10	49	3	3.59	
C	Medium dark molasses.........	1–10	In trees	547	23	10	49	3	3.72	4.57
			On poles	796	23	10	49	3	5.41	
D	Medium dark molasses......... Water only added 2 out of 3 times	1–20	In trees	366	28	10	44	3	2.77	3.08
			On poles	448	28	10	44	3	3.39	
E	Medium dark molasses......... No yeast.....................	1–10	In trees	309	28	10	44	3	2.34	2.66
			On poles	394	28	10	44	3	2.98	
F	Medium dark molasses.........	1–30	In trees	449	28	10	44	4	2.55	3.40
			On poles	747	28	10	44	4	4.24	
G	Medium dark molasses......... Yeast added first time only.....	1–10	In trees	366	28	10	44	3	2.77	3.23
			On poles	488	28	10	44	3	3 70	
H	Stock-feeding molasses.........	1–20	In trees	233	Aug. 3	10	38	3	2.04	1.71
			On poles	158	3	10	38	3	1.39	
I	Stock-feeding molasses.........	1–40	In trees	188	3	10	38	3	1.65	2.28
			On poles	331	3	10	38	3	2.90	
	Total and average...........		In trees	3,334					2.69	3.13
			On poles	4,447					3.58	

THE RELATION OF TEMPERATURE TO MOTH ACTIVITY. The opinion expressed by the writer in a previous paper[2] that there is a rather consistent relation between temperature and codling moth activity, as shown by captures of moths in trap baits, is borne out by results obtained in 1927, as is shown in Figures 51, 52, and 53. In general, considerable increases in temperature are accompanied or followed by considerable increases in the number of moths captured, and considerable decreases in temperatures by conspicuous decreases in number of moths attracted to the baits. Notable *increases* in temperature and number of moths captured are shown in Figure 51 on May 21–26, June 5, August 19, and September 18; in Figure 52, on May 14–17, June 4, June 16, July 31, and August 6 and 18; in Figure 53, on August 1, 5, and 15–23. Notable *decreases* in both temperature and number of moths captured are indicated, in Figure 51, on May 31, June 10 and 30, August 12–14, and August 29; in Figure 52, on May 20 to 29, June 10 and 23–25, August 3, 12–15, and 24–27; in Figure 53, on August 3, 13, and 25.

CONCLUSIONS. This fourth season's experiments with trap baits confirms previous conclusions that many thousands of codling moths can be captured in properly operated trap baits.

This season's tests in which apple-ferment bait was compared with molasses-ferment bait confirm those of 1926 that the molasses bait is somewhat more attractive than the former.

Certain cheaper grades of molasses are apparently as attractive as the higher-priced brands, although the "stock-feeding" molasses was found far less attractive.

Bait pans when operated at a level with the tops of the trees capture more moths than when placed within the tree tops.

The addition of yeast to molasses gives better results than depending upon chance fermentation.

The medium dark molasses seems to reach its maximum efficiency at a dilution between 1–10 and 1–20, but heavier grades may be diluted more, possibly as much as 1–20.

Better results were obtained in replenishing molasses bait with the regular formula than with water alone, although yeast need not be added at each replenishment.

The measure of supplementary control value of trap baits, as thus far developed, is still problematic, but doubtless the elimination of thousands of female moths containing eggs must indicate some reduction in the amount of infestation.

[2]See footnote on page 576.

As a means for determining the presence and abundance of codling moths in the orchard to determine spraying dates, the trap baits are worth while, and are being used for that purpose by hundreds of orchardists in the Wenatchee and Yakima Valleys of Washington.

A SIMPLE STATISTICAL METHOD FOR DETERMINING THE APPROXIMATE DURATION OF THE INSTARS OF LEAF-MINING LARVAE AND OTHERS

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ABSTRACT

It is usually laborious and difficult to determine satisfactorily the duration of the larval instars of those forms which molt in leaf-mines, bear cases, or are otherwise not readily measured without removal from shelter. A simple statistical method, which has several advantages, is described. Comparative data on *Phyllotoma nemorata* (Fallén) and *Coleophora salmani* Hein. are given as examples.

It is often desirable in insect life-history work to know the period of each larval instar, *i.e.*, the length of the several stadia. The usual method of periodical observations upon labeled individuals in culture for the determination of the duration of these stages has several disadvantages when applied to leaf-miners, case-bearers, and other forms whose ecdyses occur within an opaque structure.

The usual procedure might include, at the start of the study, a necessarily large series of eggs, each one designated, and an examination of the lot at regular time intervals, both before and after hatching. Unfortunately, a larva in a mine usually may not be measured[1] accurately without removal. It is evident that a leaf-mine opened for the removal of a larva no longer can provide the same environment for that larva; additionally, if it be replaced and the aperture not sealed (as is usually not feasible), the larva is extremely apt to escape from the mine; lastly, the handling of the larva, even if it is not visibly injured, may well have an effect on the length of the stadium.

These disadvantages may be eliminated if small *fractions* of the original lot are examined (and discarded at each interval) until a representative number of the larvae have reached, for example, the second

[1]The measurement of the head capsule, which, as Dyar (1890) noted is not subject to growth during a stadium, is the logical one to make and, thus, to classify larvae. (Dyar's Rule, that the head measurements of the instars form a geometrically progressive series, is, of course, too well known to ampliry here.) A paper showing that Dyar's Rule may be applied to successive instars with greater reliability when based on *averaged* measurements of known instars, is in preparation.

instar. The figures thus obtained, when averaged, give a mean duration of the first instar. This procedure with other arbitrary portions of the remainder in each stage, repeated for each stadium until *all* of the lot have been utilized, may give a mean for each instar. It is obvious that the number started with must be large. It is likewise apparent that, unless the mining habits of each instar be strikingly dissimilar so that positive determinations can be made throughout macroscopically the investigator with this method is obliged to establish his "mean duration of instar" as definite periods as he proceeds, *i.e.*, *all* the larvae in the lot of undissected mines must be *assumed* to have molted at the precise time the mean (based on a fraction of the lot) just determined would apply.[2] With this method it is clear, unfortunately, that there is always the decided possibility that the number of samples will be too small to give a truly representative mean in each case. Especially, if slight errors should be cumulative, later data might be considerably at variance with the truth. Lastly, larvae so studied are often in culture in the laboratory under conditions which, at their best, are merely approximations of those in the field.

While examining a series of white birch (*Betula papyrifera*) leaves daily for other data, a simple "statistical" method to determine the approximate duration of larval instars came to mind—one that has probably occurred to other workers but which had not been observed in the literature[3]—which may prove advantageous. This method, with an equivalent amount of time and labor, permits the examination of a larger sample of material, and uses material fresh from the field where it

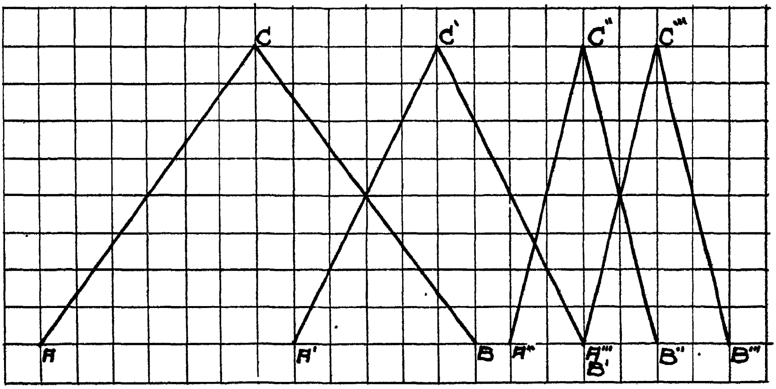
[2]A simple hypothetical case: 1000 first instar larvae under consideration; 10, or one per cent, subject to dissection each day for ten days; the first post-embryonic ecdysis noted to occur at a range of five to ten days after hatching, with a mean, perhaps, of 8.3 days. This figure is then taken to fix the time of the first molt for the remaining ninety per cent of the original lot, and so on for successive stadia.

[3]Though not known at the time, Laughlin, a cytologist, used a somewhat analogous method to determine the length of the several phases in mitosis when he found them to be directly proportional, roughly, to the comparative abundance of the mitotic figures in sectioned material.

The following statement in a paper by Calvert (1929) was not seen until this article was in press:

"Two methods of ascertaining the duration and the differences in size and in structure of the successive instars of insects have been discussed by Wesenberg-Lund (1913, pp. 374 *et seq.*) with special reference to the Odonata, that of rearing known individuals in aquaria and that of comparing specimens taken in nature at regular intervals (analysis of populations). He has set forth the obstacles which he met in following each of these. Unquestionably the former method—that of rearing—gives the most dependable results when its technical difficulties are overcome."

has had the advantage of continuous natural conditions. Briefly, it includes the collection of mines at regular intervals, the positive determination of the stages with the aid of an ocular micrometer disc, and the entry of these data to show the number of each instar obtained at each interval. Determinations, of course, should immediately follow collection since development will continue in neglected material. The value of the data secured is dependent upon the size of the sample taken, the frequency of the interval, and, especially, the uniformity of the source of the material. In effect, the area collected from, if it approximates a constant, becomes a transcendent laboratory culture.



AA' : 7 CC' : 5 A'A'' : 6 C'C'' : 4 A''A''' : 2 C''C''' : 2
BB' : 3 B'B'' : 2 B''B''' : 2

Fig. 54.—Diagram to show that, even though successive stadia may be spread over greater or lesser periods, when the curves are symmetrical distances $\frac{AA'+BB'}{2} = CC'$, $\frac{A'A''+B'B''}{2} = C'C''$, etc.

The larvae measured at each time interval are a classified "cross-section" of the population of the given area at those times.

The length of each stadium may be calculated as the distance in days (or half-days) from one mean to the next, or more simply, if the mean be arbitrarily taken as *half-way* between the extremes of the first and last dates when a given instar occurs in the material, then the "distance" from the first date of one stage to the first date of the next, plus the distance between the last dates of the same two stages, divided by two, will give the same figure with less trouble. Fig. 54 illustrates this. The basis for the use of this arbitrary mean is the assumed tendency on the part of the larva instars to form frequency curves which are symmetrical and without skew.

TABLE 1. THE INCIDENCE OF THE SEVERAL STAGES OF THE BIRCH LEAF-MINING, SAWFLY, *Phyllotoma nemorata* (FALLÉN) AND OF THE BIRCH CASE-BEARER *Coleophora salmani* HEIN., BY DATE*

	Phyllotoma								Coleophora					
Date	Egg	I	II	III	IV	V	VI	VII	Egg	I	II	III	IV	V
6/15	x	–	–	–	–	–	–	–	–	–	–	–	–	–
6/16	x	–	–	–	–	–	–	–	–	–	–	–	–	–
6/17	x	–	–	–	–	–	–	–	–	–	–	–	–	–
6/18	x	–	–	–	–	–	–	–	–	–	–	–	–	–
6/19	x	–	–	–	–	–	–	–	–	–	–	–	–	–
6/20	x	–	–	–	–	–	–	–	–	–	–	–	–	–
6/21	x	–	–	–	–	–	–	–	–	–	–	–	–	–
6/22	x	–	–	–	–	–	–	–	–	–	–	–	–	–
6/24	x	–	–	–	–	–	–	–	–	–	–	–	–	–
6/25	0	–	–	–	–	–	–	–	–	–	–	–	–	–
6/26	x	–	–	–	–	–	–	–	–	–	–	–	–	–
6/27	x	–	–	–	–	–	–	–	–	–	–	–	–	–
6/28	x	–	–	–	–	–	–	–	–	–	–	–	–	–
6/29	0	–	–	–	–	–	–	–	–	–	–	–	–	–
7/1	x	–	–	–	–	–	–	–	–	–	–	–	–	–
7/2	x	–	–	–	–	–	–	–	–	–	–	–	–	–
7/3	x	–	–	–	–	–	–	–	–	–	–	–	–	–
7/4	0	–	–	–	–	–	–	–	–	–	–	–	–	–
7/5	x	–	–	–	–	–	–	–	–	–	–	–	–	–
7/6	x	–	–	–	–	–	–	–	–	–	–	–	–	–
7/8	x	–	–	–	–	–	–	–	–	–	–	–	–	–
7/9	x	–	–	–	–	–	–	–	–	–	–	–	–	–
7/10	x	x	–	–	–	–	–	–	–	–	–	–	–	–
7/11	x	x	–	–	–	–	–	–	–	–	–	–	–	–
7/12	x	x	–	–	–	–	–	–	–	–	–	–	–	–
7/13	x	x	–	–	–	–	–	–	–	–	–	–	–	–
7/15	x	x	–	–	–	–	–	–	–	–	–	–	–	–
7/16	x	x	–	–	–	–	–	–	–	–	–	–	–	–
7/17	x	x	–	–	–	–	–	–	–	–	–	–	–	
7/18	–	0	–	–	–	–	–	–	x	–	–	–	–	–
7/19	–	x	x	–	–	–	–	–	x	–	–	–	–	–
7/20	–	0	0	–	–	–	–	–	x	–	–	–	–	–
7/22	–	x	x	–	–	–	–	–	x	–	–	–	–	–
7/23	–	x	x	–	–	–	–	–	x	–	–	–	–	–
7/24	–	x	x	–	–	–	–	–	x	–	–	–	–	–
7/25	–	x	x	–	–	–	–	–	x	–	–	–	–	–
7/26	–	x	x	x	–	–	–	–	x	–	–	–	–	–
7/27	–	x	x	x	–	–	–	–	x	–	–	–	–	–
7/29	–	x	x	x	–	–	–	–	x	–	–	–	–	–
7/30	–	x	x	x	–	–	–	–	x	–	–	–	–	–
7/31	–	x	x	x	–	–	–	–	x	–	–	–	–	–
8/1	–	x	x	x	–	–	–	–	x	–	–	–	–	–
8/2	–	x	x	x	–	–	–	–	x	–	–	–	–	–
8/3	–	–	x	x	x	–	–	–	x	–	–	–	–	–
8/5	–	–	x	x	x	–	–	–	x	–	–	–	–	–
8/6	–	–	x	x	0	–	–	–	x	–	–	–	–	–
8/7	–	–	x	x	x	–	–	–	x	x	–	–	–	–
8/8	–	–	x	x	x	–	–	–	x	x	–	–	–	–
8/9	–	–	x	x	x	–	–	–	x	x	–	–	–	–
8/10	–	–	x	x	x	–	–	–	x	x	–	–	–	–

*The actual number per day are not given since, in these cases, they were not used to determine the true mean; instead, the arbitrary mean of the point half-way between the first and last date of the incidence of a given stadium was used as a basis for calculation.

TABLE 1—*Continued*

Date	Phyllotoma Egg	I	II	III	IV	V	VI	VII	Coleophora Egg	I	II	III	IV	V
8/12..........	–	–	x	x	x	x	–	–	x	x	–	–	–	–
8/13..........	–	–	–	0	x	0	–	–	x	x	x	–	–	–
8/14..........	–	–	–	x	x	x	–	–	x	x	x	–	–	–
8/15..........	–	–	–	x	x	x	–	–	x	x	x	–	–	–
8/16..........	–	–	–	x	x	x	–	–	x	x	x	–	–	–
8/17..........	–	–	–	x	x	x	–	–	0	x	x	–	–	–
8/19..........	–	–	–	x	x	x	x	–	x	x	x	–	–	–
8/20..........	–	–	–	x	x	x	0	–	x	x	x	–	–	–
8/21..........	–	–	–	x	x	x	x	–	x	x	x	–	–	–
8/22..........	–	–	–	x	x	x	x	–	x	x	x	–	–	–
8/23..........	–	–	–	x	x	x	x	–	x	x	x	–	–	–
8/24..........	–	–	–	–	x	x	x	–	–	x	x	–	–	–
8/26..........	–	–	–	–	x	x	x	–	–	x	x	–	–	–
8/27..........	–	–	–	–	x	x	x	–	–	x	x	–	–	–
8/28..........	–	–	–	–	x	x	x	–	–	x	x	–	–	–
8/29..........	–	–	–	–	x	x	x	–	–	x	x	–	–	–
8/30..........	–	–	–	–	x	x	x	–	–	x	x	–	–	–
8/31..........	–	–	–	–	–	x	x	–	–	x	x	x	–	–
9/2...........	–	–	–	–	–	x	x	x	–	x	x	x	–	–
9/3...........	–	–	–	–	–	0	x	0	–	x	x	x	–	–
9/4...........	–	–	–	–	–	x	x	0	–	x	x	x	–	–
9/5...........	–	–	–	–	–	x	x	0	–	x	x	x	–	–
9/6...........	–	–	–	–	–	x	x	x	–	x	x	0	–	–
9/7...........	–	–	–	–	–	0	x	0	–	x	x	0	–	–
9/9...........	–	–	–	–	–	0	x	x	–	–	x	x	–	–
9/10..........	–	–	–	–	–	x	x	0	–	–	x	x	–	–
9/11..........	–	–	–	–	–	–	x	x	–	–	x	x	–	–
9/12..........	–	–	–	–	–	–	x	0	–	–	x	x	–	–
9/13..........	–	–	–	–	–	–	x	0	–	–	x	x	–	–
9/14..........	–	–	–	–	–	–	x	x	–	–	x	x	–	–
9/16..........	–	–	–	–	–	–	0	x	–	–	x	x	–**	–
9/17..........	–	–	–	–	–	–	0	0	–	–	x	x	–	–
9/18..........	–	–	–	–	–	–	0	0	–	–	x	x	–	–
9/19..........	–	–	–	–	–	–	0	0	–	–	x	x	–	–
9/20..........	–	–	–	–	–	–	0	0	–	–	0	x	–	–
9/21..........	–	–	–	–	–	–	0	x	–	–	0	x	–	–
9/23..........	–	–	–	–	–	–	x	x	–	–	0	x	–	–
9/24..........	–	–	–	–	–	–	–	x	–	–	x	x	–	–
9/25..........	–	–	–	–	–	–	–	x	–	–	–	x	–	–
9/26..........	–	–	–	–	–	–	–	0	–	–	–	x	–	–
9/27..........	–	–	–	–	–	–	–	x	–	–	–	0	–	–
9/28..........	–	–	–	–	–	–	–	x	–	–	–	x	–	–
9/30..........	–	–	–	–	–	–	–	x	–	–	–	x	–	–
10/1..........	–	–	–	–	–	–	–	x	–	–	–	x	–	–
10/2..........	–	–	–	–	–	–	–	0	–	–	–	x	–	–
10/3..........	–	–	–	–	–	–	–	x†	–	–	–	x	–	–
10/4..........	–	–	–	–	–	–	–	–	–	–	–	x	–	–
10/5..........	–	–	–	–	–	–	–	–	–	–	–	x	–	–
10/7..........	–	–	–	–	–	–	–	–	–	–	–	0	–	–
10/8..........	–	–	–	–	–	–	–	–	–	–	–	0	–	–
10/9..........	–	–	–	–	–	–	–	–	–	–	–	x	–	–

**The data for the fourth instar were incomplete, while the fifth instar does not occur until the following spring.

†Note: While seventh instar larvae may be found throughout the winter, this was the last date when any which had not spun the lens-shaped hibernaculum were obtained from the regular area of collection.

TABLE 2. THE DURATION BY DAYS OF THE SEVERAL STAGES OF *Phyllotoma nemorata* AND *Coleophora salmani* AS OBTAINED BY COMPARATIVE METHODS

	Phyllotoma		Coleophora	
Stage	By Culture	Statistically	By Culture	Statistically
Egg	No. cases: 44 Range: 12–33 Modes: 17, 19. Mean: *20.8*	1st. egg–1st. I (6/15–7/10): 25 last to last (7/17–8/2): 16 41 ÷ 2: *20.5*	No. cases: 84 Range: 17–24 Modes: 18, 22 Mean: *19.5*	1st. egg–1st. I (7/18–8/7): 20 last to last (8/23–9/7): 15 35 ÷ 2: *17.5*
I	No. cases: 3 Range: 8–11 Mean: *9.3*	1st. I–1st. II (7/10–7/19): 9 last to last (8/2–8/12): 10 19 ÷ 2: *9.5*	No. cases: 65 Range: 7–14 Modes: 11, 13 Mean: *10.8*	1st. I–1st. II (8/7–8/13): 6 last to last (9/7–9/24): 17 23 ÷ 2: *11.5*
II	*dissected* No. cases: 2 Mean: *10* *estimated* No. cases: 32 Range: 8–14 Modes: 11, 14 Mean: *11.7*	1st. II–1st III (7/19–7/26): 7 last to last (8/12–8/23): 11 18 ÷ 2: *9*	No. cases: 23 Range: 13–16 Modes: 14, 15 Mean: *14.5*	1st. II–1st. III (8/13–8/31): 18 last to last (9/24–10/9): 15 33 ÷ 2: *16.5*
III	*dissected* No. cases: 4 Range: 6–9 Mode: 7 Mean: *7.25* *estimated* No. cases: 27 Range: 5–9 Modes: 6, 8 Mean: *7.3*	1st. III–1st. IV (7/26–8/3): 8 last to last (8/23–8/30): 7 15 ÷ 2: *7.5*		
IV	*dissected* No. cases: 4 Range: 6–8 Mode: 8 Mean: *7.25* *estimated* No. cases: 19 Range: 6–9 Modes: 7, 6 Mean: *6.8*	1st. IV–1st. V (8/3–8/12): 9 last to last (8/30–9/10): 11 20 ÷ 2: *10*		
V	*dissected* No. cases: 3 Range: 7–8 Mode: 8 Mean: *7.7* *estimated* No. cases: 13 Range: 6–8 Modes: 7, 8 Mean: *7.4*	1st. V–1st. VI (8/12–8/19): 7 last to last (9/10–9/23): 13 20 ÷ 2: *10*		

TABLE 2—*Continued*

VI	No. cases: 11 Range: 20–26 Modes: 20, 22 Mean: *21.9*	1st. VI–1st. VII (8/19–9/2): 14 last to last* (9/23–10/3): 10 24÷2: *12*
VII (Prehiber- naculum period only)	No. cases: 9 Range: 3–11 Modes: 7, 3 Mean: *5.9*	1st. VII–1st. hibernaculum (9/2–9/9): *7***

**i.e.*, last date seventh instar found without a hibernaculum.
**The date, Sept. 9, for the first hibernaculum noted is not given in Table 1.

In contrast with the method first discussed, the definite age of no individual larva is ever obtained; it may be pointed out, however, that the age of an individual is usually of importance only to the extent that it contributes to the determination of a mean. *That*, apparently, can be derived closely by the method just described. Two cases, unfortunately with samples smaller than desirable— since no critical test of this was planned originally— may be of interest. These data[4] were obtained incidentally while engaged in securing other data.

The *Phyllotoma* data in the tables are based upon a daily random collection of 15 white birch leaves, a sample which contained up to 35 larvae; the daily sample for the *Coleophora* data, which were taken by A. M. Gillespie, Junior Entomologist, Maine Forest Service, was 100 white birch leaves; this latter material yielded up to 69 eggs and up to 51 larvae daily. Care was taken to collect over the same route on a permanently delimited area, while the factors of shade or sun and the like were kept as uniform as possible.

DISCUSSION. It may be noted that, even with these small samples, the data obtained by the comparative methods are reasonably consistent with the exception of a considerable discrepancy in the duration of the sixth instar in *Phyllotoma*. This, possibly, can be explained partly by the smallness of the sample in both cases, and partly by the tendency for cumulative error when the progressive development of a lot is estimated to have reached definite points from the determinations of the duration of the several stages obtained from small fractions of this lot. It may be said, in addition, that there is an apparent tendency on the part of these sawfly larvae to have a more irregular stadium in

[4]These data were obtained in the course of a biological study upon these economically important insects and were used with the permission of H. B. Peirson, Entomologist of the Maine Forest Service.

the sixth instar than in the earlier instars. It was definitely noted, for example, that drouth markedly decreased the feeding rate and unduly prolonged the sixth stadium. On a number of occasions, sixth instar larvae, which had become quiescent, resumed feeding after a local shower had apparently increased the succulence of the leaf tissue, ceased a day or so later, and resumed again at the incidence of a second shower. It is natural that such irregularities would be more apparent with a small sample than with a larger one.

There are, of course, a number of more or less tacit assumptions in force when this statistical method is operative. These include: (1) As mentioned, the basic and rather inclusive assumption that the periodical incidence of a given instar will form, as it waxes, reaches a peak, and wanes, a symmetrical inverted V-shaped curve. (2) The assumption that all larvae are impelled to, and do, molt after a definite summation of factors such as units of ingested food, thermal increments, and the like. (3) The assumption that the date of the initiation of a stage has no effect upon the length of that stage, *e.g.*, the hatching period, tends to be of the same length regardless of whether the egg was the first one laid, the last one, or any intermediate one during the oviposition period, etc. (4) The assumption that the mean duration of any instar is unaffected by the death rate (from any and all causes) of that instar. (5) The assumption that all plant units of the delimited collection area are subject to an identity of those conditions which foster development of the insect. There are other assumptions, of minor importance, of about the same order.

There is some source of Error in all these assumptions; the Probable Error could be determined, probably, only after a special, modified formula had been obtained to fit these assumptions. A critical test of this statistical method, with the refinements afforded by large samples and short time intervals, might be worth while and should aid in the development of formulae that would assist in securing still closer approximations of the truth. Basically, however, the principle of this statistical method would appear to be sound and to prove at least as accurate for the special class of larvae considered, as the first method discussed.

It may not be amiss to pause briefly, and to interpolate these speculative queries:

1. Which is the more important factor in ecdysis, an accumulation of temperature (thermal increments as used by Peairs) *or* the number of decigrams of food consumed?

2. If these and other factors be reasonably definite, how advisably may the duration of a larval instar be expressed in such coarse units as days?

Unless a number of counts, very much larger than usual, be made, a "normal season" be determined, and certain variables be evaluated, it would seem that the length of no larval instar can be given as anything but an approximation. In economic entomology, however, it is very often essential that some concept of the duration of the several larval stadia be obtained. These approximations, derived as accurately as possible, are useful and are very much better than no data at all.

It is not suggested that the statistical method treated herein might be preferable with insects whose immature stages may be kept visible at all times, or where material is scarce. It is believed, however, in the case of certain leaf-miners, case-bearers, and other larvae, the molts of which are hidden from view, and when in abundance, that this method may be found fully as accurate as any other; that it is time-saving (since caging and numbering are eliminated); and that it possesses the still further advantage that other data[5] may be obtained simultaneously. Care should be taken to make the sample adequately large, the time interval short and, especially, to keep the area of collection approximately a constant.

References

Calvert, Philip P. 1929. Different rates of growth among animals with special reference to the Odonata. Proc. Amer. Phil. Soc. 68[3]:227–274.

Dyar, H. G. 1890. The number of molts of lepidopterous larvae. Psyche. 5:420–422.

Laughlin, H. H. 1919. Duration of the several mitotic stages in the dividing root-tip cells of the common onion. Carnegie Inst. of Wash. Publ. 265. pp. 1–48.

Peairs, L. M. 1927. Some phases of the relation of temperature to the development of insects. W. Va. Agr. Exp. Stn. Bul. 208. pp. 1–62

Taylor, Raymond L. In preparation. On "Dyar's Rule" and its application to sawfly larvae, with special reference to *Phyllotoma nemorata* (Fallén).

Wesenberg-Lund, C. 1913. Odonaten Studien. Internat. Rev. d. gesam. Hydrobiol. u. Hydrogr., VI, Heft 2–3, pp. 155–228, Heft 4–5, pp. 373–422.

[5]Such as the percentage of infestation, the number of mines per plant unit, the parts of the plant affected, etc.

SUPPLEMENTARY CONTROL MEASURES FOR THE ORIENTAL FRUIT MOTH[1]

By S. C. CHANDLER, *Illinois State Natural History Survey*

ABSTRACT

Bands placed around peach trees in spring caught an average of 2.2 Oriental Fruit Moth larvae per band up to the time of Elberta harvest. Bands placed on Krummel's October and Heath Cling peach trees after Elberta harvest caught from 6 to 151 larvae per band for the rest of the season. An interesting larval habit in connection with banding is discussed.

Paradichlorobenzene showed poor results in grower made treatments in 1928. Tests by the author in 1929 gave a kill of from 70% to 90%.

During the fall of 1928 and of 1929 banding and the use of paradichlorobenzene for the Oriental Fruit Moth, *Laspeyresia molesta* Busk, were tested in southern Illinois.

BANDING

Bands placed late in the season of 1928 gave sufficient promise to warrant further tests. In the spring of 1929, 10 bands were placed in each of four Elberta peach orchards in Pulaski County, Illinois, which is the area most heavily infested in the state. The two types of bands used were of material commonly employed for bagging. Both were tarred on the inside, and in addition the surface placed next to the tree was faced with burlap in the case of one and a cheese cloth of wide mesh in the case of the other. Both types had been among the best in our Codling Moth tests. The selection of orchards was made as follows;—

Orchard No. 1, given little care, trees located close to quinces badly infested in 1928.

Orchard No. 2, given moderate care, trees selected in and next to a block of Krummel's October which was 35% infested in 1928. (Krummel block listed as Orchard No. 5 in Table 2.)

Orchard No. 3, given best of care, showing the greatest infestation in 1928 of any Elberta orchard in the section.

Orchard No. 4, given moderate care, selected merely for geographical location in the peach section.

Table 1 gives the numbers of larvae and pupae collected under the 40 bands in the above mentioned orchards.

[1]Contribution No. 3 of Project 10.6, Ill., State Natural History Survey.

TABLE 1. NUMBERS OF LARVAE AND PUPAE COLLECTED FROM BANDS IN ELBERTA PEACH ORCHARDS

Date Collected	Larvae and Pupae Collected from Orchards No. 1	No. 2	No. 3	No. 4	Total	Tree Average
May 22	4	3	0	0	7	.17
May 28	3	2	0	0	5	.12
June 6	1	0	0	0	1	.002
June 11	0	0	0	0	0	0.
June 27	–	–	5	–	5	.02
July 8	3	5	1	1	10	.25
July 22	1	1	2	2	6	.15
July 30	7	4	13	4	28	.7
Aug. 8	5	5	15	2	27	.7
Aug. 19 (after harvest)	0	0	0	0	0	0.0
Season's Totals	24	20	36	9	89	2.2

As will be seen by an inspection of Table 1 the bands in Orchards No. 1 and 2, located next to sources of the winter's carry-over, caught the first larvae of the season. After the middle of June, when twig infestation had spread to all orchards, bands in Nos. 3 and 4 began catching larvae. After that time the thriftiest of all, No. 3, outstripped the others in total larvae collected. This orchard proved to be one of the worst infested Elberta orchards of the section that year, as it had been in 1928, yet it will be seen that a total of only 36 larvae were collected from 10 bands in it, or 3.6 per band for the season. The average for the four orchards was only 2.2 larvae per band. It would seem from this that up to the time of the Elberta harvest banding was ineffective.

After the Elberta harvest, Krummel's October and Heath Clings, were banded. Table 2 gives the record of these collections.

TABLE 2

Date Collected	Number of Larvae and Pupae Collected: Orchard No. 5	Orchard No. 6	Orchard No. 7 Block 1	Orchard No. 7 Block 2
Sept. 3	288	——	——	——
Sept. 9	76	——	——	——
Sept. 5	——	639	1165	——
Sept. 19	——	435	——	——
Sept. 21 and 23	——	——	2471	——
Sept. 23–25	——	——	——	2112
Totals	364	1074	3636	2112
No. of bands	62	20	24	61
Average per band	5.9	53.7	151.5	34.6
Date banded	Aug. 19	Aug. 26	Aug. 26	Sept. 5
Collection period	21 days	24 days	27 days	20 days

It will be seen that the averages of totals per band range from 5.9 to 151.6. The following statements may account in part for these big differences;—

Orchard No. 5 was banded on August 19, and the peaches harvested earlier than usual, September 1. Trees were stripped of fruit by September 3 and all drops picked up in the next few days.

Orchard No. 6 was picked by September 19, and all drops removed and buried.

Orchard No. 7 offered the greatest possibilities for the collection of larvae. Due to infestation and prices very few peaches were picked, and most of the drops were allowed to remain on the ground. Cheesecloth faced bands were used in all of the orchards except Block 2 of No. 7, where a tarred felt was used. The greatest difference between these two blocks in the same orchard, however, was in the size of the trees. Block 1 produced a much larger crop per tree. The average circumference of the trunks where the bands were placed was 21.4 inches in Block 1 and 12.5 inches in Block 2. From Table 2 it would appear that banding late maturing varieties after the Elberta season offers possibilities. It certainly provides a convenient method of collecting a winter's supply of larvae for the entomologist.

To determine the direction from which the larvae come that enter the bands a few trees were banded both on the trunks and in the main branches. About as many larvae were found in the upper as in the lower bands, indicating that they come from both directions. In Orchards 6 and 7 where such large numbers of larvae were found, it was noticed that fully 75% of the larvae cocooned just inside the band, making in many trees a nearly solid ring of cocoons, both at the upper and lower edges of the band. About as many were in the upper bands as in the lower.

USE OF PARADICHLOROBENZENE. In the fall of 1928 trees treated by the growers with P. D. B. at the usual rates per tree were examined for live Oriental Fruit Moth larvae. Table 3 summarizes the data obtained.

TABLE 3. USE OF P.D.B. IN GROWER TREATED ORCHARDS IN 1928

Orchard No.	Date Treated	Date Examined	No. Trees Examined	Larvae Found Live	Dead	Total	% Dead
1.........	Sept. 25	Oct. 30	7	26	14	40	35%
2.........	Oct. 10–13	Nov. 5	5	6	2	8	25%
3.........	Oct. 19	Nov. 20	2	84	12	96	12%

In the fall of 1929 trees were treated by the author in two orchards, using 1 oz. of P. D. B. on 7 year old trees. In one of them, listed as No. 4 in Table 4, the trees were treated in the regular manner. In the other, Orchard No. 5, the ground level was first raised 3 to 4 inches in order to bring the material within reach of as many larvae as possible. Both

orchards were treated September 28 and examined October 11 to 15. In No. 4, 20 trees were treated and 20 left for a check, but unfortunately all but 7 of each were pulled out before they could be examined. In No. 5 because of the irregular procedure of raising the ground level, a check was kept on the kill of peach borer larvae, *Aegeria exitiosa* Say. These data are presented in Table 4.

TABLE 4. USE OF P.D.B. IN EXPERIMENTAL ORCHARD IN 1929

		Oriental Fruit Moth Larvae						Peach Borer Larvae					
		Treated			Check			Treated			Check		
No.	Treat-ment	Live	Dead	% Dead	Live	Dead	% Dead	Live	Dead	% Dead	Live	Dead	% Dead
4	Regular	3	30	90%	68	6	8%	–	—	——	—	–	–
5	Ground level raised	35	116	70%	189	6	3%	3	29	90%	17	0	0

The applications were made with the ground in good condition. A record of soil temperatures 3 inches below the surface showed a maximum of 72° F. on the north side of the tree for the first two days. After a rain of .66 inch temperatures were lower for the rest of the period between treating and examining, but the minimum was never lower than 55 at night on the north side. The maximum in the middle of the day was 66. One other rain of .42 inch occurred 8 days after treatment.

An examination of Tables 3 and 4 will show that the efficacy of P. D.B. is not a foregone conclusion. In the case of Orchards No. 2 and 3 the poor kill may have been due to too late applications. Our recommended dates for this section are from September 25 to October 15, for the Peach Borer, but the latter date may depend upon soil temperatures. Table 4 would indicate that the practice of first raising the ground level might result in a reduction in kill. It will be seen that under conditions that killed 90% of the peach borer larvae, 70% of the Oriental Fruit Moth larvae were killed.

In the hibernation studies carried on during the winter of 1928–29 by the author, it was found that of 487 larvae found on trees, 33% were located between the ground line and a point 3 inches above the ground, and might be reached by P. D. B. These records were made from trees headed at the average height. It may be that on very low headed trees a larger percent might be reached.

In considering both the practices of banding and the use of P. D. B. it should be clearly born in mind that numbers of larvae on late maturing varieties like Krummel's October are vastly greater than on the two principal varieties, Elberta and Hale. During the winter of 1928–29 hibernation studies of 5 Krummels and Heath clings showed a total of 816 larvae on the trees and on the ground under them, as compared with 4 larvae on and under 9 Elbertas.

A DESCRIPTION OF THE IMMATURE STAGES OF *HIPPELATES PUSIO* LOEW AND A BRIEF ACCOUNT OF ITS LIFE HISTORY

By W. B. HERMS[1] and R. W. BURGESS[2]

ABSTRACT

Contains a brief description with illustrations of the hitherto unknown immature stages of *Hippelates pusio*. The life history from egg to imago requires about three weeks as bred out in the laboratory at Coachella, California.

During the past several years the Hippelates fly problem of the Coachella Valley (California) has been becoming more and more acute and has lately been attracting nation-wide attention (Science Supplement, March 1, 1929, p. xiv). Not only is this persistent gnat believed to be an effective vector of conjunctivitis or pink eye (Schneider 1927), but because of its annoying habits it also seriously hampers laborers in the field, hand pollination of dates and the picking of fruit are made particularly difficult. Mr. E. P. Carr of Thermal, under date of March 18, 1929, writes, "We have had a serious epidemic of trachoma and conjunctivitis this year and now have two special nurses and a special health deputy at work cleaning up eye conditions in our schools. This brings home the Hippelates problem all the nearer." The Hippelates fly is truly a most trying pest.

The senior author first began a study of this problem in June 1926 (Herms 1926) from which time at intervals during the summers of 1926, 1927 and 1928 various members of the staff of the Division of Entomology and Parasitology of the University of California as well as certain student assistants were in residence at Coachella for short periods of time for the purpose of discovering the breeding habits of this insect. As the work progressed it became obvious that we were dealing with a baffling problem which required a more intensive and persistent campaign, hence in March of 1928 an abatement district was organized, the tax proceeds of which made it possible to build a small laboratory at Coachella and provide a resident entomologist (see Herms 1928). Mr. Robert W. Burgess, then Assistant in Entomology and Parasitology in the University of California, was put in charge of this work beginning January 1, 1929, having had some experience with the problem during the previous summer.

Under date of March 8, 1929, Mr. F. C. Bishopp, Principal Entomologist in Charge, Insects Affecting Man and Animals, U. S. Bureau of

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[2]Entomologist, Coachella Valley (Calif.) Abatement District, Coachella.

Entomology, wrote as follows (in a letter to the senior author), "Perhaps you have been informed of the fact that the second deficiency bill passed by Congress a few days ago carried an item of $12,000 for investigational work relating to Hippelates. It seems that the officers of the Coachella Mosquito Abatement District, following a meeting called to discuss the Hippelates problem, presented a strong petition to General Lord, Director of the Budget, urging the provision of funds to enable the Bureau of Entomology to undertake an investigation of the Hippelates problem. This appeal made such an impression on the Budget that it recommended to the President the incorporation of the above mentioned item in the deficiency bill to provide for the work. According to tentative plans we are to take up the study from more or less of an interstate point of view......" On April 15 (1929) both Mr. Bishopp and Mr. D. C. Parman were in Berkeley and discussed with Herms the plan of cooperation. Mr. Parman then immediately took up his work with traps in the Coachella Valley where he had left it during the previous summer and with funds provided by Congress, Parman and Burgess built several dozen large canvas-covered cages (6 ft. long, 3 ft. wide and 1 foot high) and distributed these widely in the valley, under a variety of

FIG. 55—Egg of *Hippelates pusio* (Greatly enlarged)

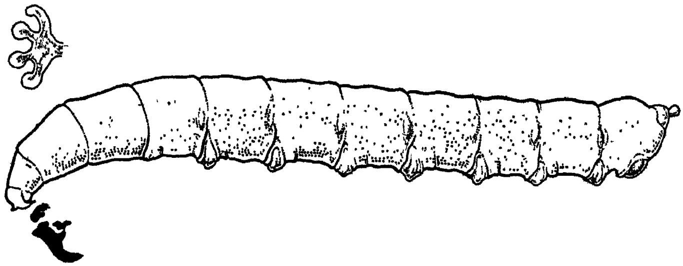


FIG. 56—Full grown larva of *Hippelates pusio*, showing also detail of anterior spiracular process and mouth hook (Greatly enlarged)

conditions. These cages were provided with a pint jar at each end for the purpose of trapping such insects as might emerge in the area covered by any particular cage. These jars are emptied once a week and the

contents examined. A letter from Mr. Burgess dated June 17, 1929 states that "......fourteen or fifteen out of the forty cages have yielded Hippelates." Much of Mr. Burgess' time has been devoted to a search for the immature stages of the fly, continuing the laboratory experiments which had been started by Herms during the summer of 1926.

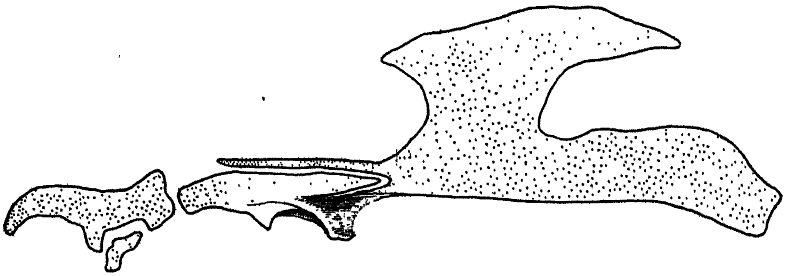


FIG. 57—Entire cephalopharyngeal skeleton of *Hippelates pusio* (Greatly enlarged)

Knowledge of the general appearance of the eggs of *Hippelates pusio* was secured during the summer of 1926 by dissecting gravid female gnats, but eggs actually oviposited by this species were not seen until about the middle of May of this year (1929) and these were discovered by Mr. Burgess in a pint fruit jar containing, together with trapped

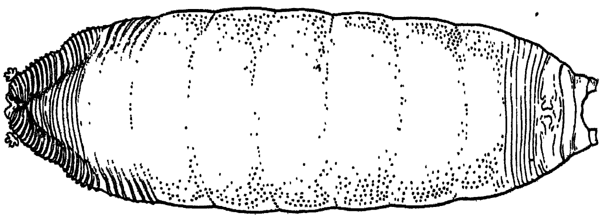


FIG. 58—Puparium of *Hippelates pusio* (Greatly enlarged)

living gnats, "water soaked shredded brown fibre from corrugated cardboard packing cases." Since that time eggs which are deposited singly have been secured repeatedly in jars with water soaked wheat straw and chaff as well as the brown paper. Immature stages have as yet not been taken under field conditions. The entire life history in the laboratory with the temperature ranging from 80° to 105° F. required about three weeks.

Description of Stages

Egg—The eggs are pearly white, measuring about .5 mm. in length. They are subcircular in cross section, prominently curved at one side and nearly straight on the opposite side. There is a prominent cap over the micropyle. The surface bears many fine longitudinal ridges often forming junctions (See Fig. 55).

Larva—The full-grown larvae average about 3 mm. in length. They are whitish (opalescent) in color, gradually turning brown in alcohol, rather pointed anteriorly and truncate posteriorly. A pair of very minute ocular tubercles are present. The anterior spiracular processes, also minute, consist of four spiracular papillae in a vertical row (Fig. 56, detail). The mouth hooks (Fig. 56) are gently curved. The entire cephalopharyngeal skeleton of the mature larva is shown in Figure 57.

Puparium—The puparium averages about 2.25 mm. in length. It is light straw color at first, turning chestnut brown as it grows older. The anterior spiracles of the larva can be easily seen (Fig. 58).

Literature

Herms, W. B. 1926. Hippelates flies and certain other pests of the Coachella Valley, California. Jour. Econ. Entom., vol. 19, no. 5 (October 1926), pp. 692–695.

Herms, W. B. 1928. The Coachella Valley (California) Hippelates fly project. Jour. Econ. Entom., vol. 21, no. 5 (October 1928), pp. 690–693, 1 pl.

Schneider, Albert. 1927. An introductory report on pseudo-trachoma endemic in the Salton Sea region of California. Medical Sentinel, vol. 35, no. 3 (March 1927), pp. 154–161.

MEXICAN SUGAR CANE-BORERS AND THE PARASITE *TRICHOGRAMMA*

By Stanley E. Flanders, *Citrus Experiment Station, Riverside, Calif.*

The Haciendas de Redo y Cia, situated south-west of Culiacan in the state of Sinaloa, include one of the most extensive sugar plantations on the West Coast of Mexico. Approximately 10,000 acres are planted to cane. The soil and climate are optimum for the growing of sugar cane but an inadequate water supply creates conditions very favorable for the development of certain cane pests. Within the past few years the depredations of the borers have reached a severity seldom attained elsewhere. In 1929 the writer was employed during February, March, and April to establish a biological control laboratory and to make a preliminary survey of the borer situation.

At least three species of borers were found to be responsible for the injury to the cane, *Chilo loftini* and two species of *Diatraea*. A more or

less general survey showed that about 97 per cent of the stalks and 25 per cent of the joints were attacked. The activity of these insects results in the killing of the cane in the field, reduction of the amount of sucrose in the cane, and an increase of fabrication costs due to poor quality cane juices. The annual loss is exceedingly high.

Chilo loftini is the most uniformly distributed and the most numerous of the three species of borers. From the standpoint of fabrication it is the most serious since it opens so many "portals of entry" for the sucrose-reducing fungus, *Colletotrichum falcatum*. This "red rot" fungus is so abundant that the crushed cane after passing through the first set of rollers at the mill appears splotched with red.

About 75 per cent of the infestation in the joints is attributable to *Chilo*. The factors that enable it to become so numerous are its continuous breeding throughout the year in large grasses, corn and cane, the protection of its eggs from parasitism by oviposition in crevices, as between the leaf sheath and the stalk, and an optimum environment in cane grown under insufficient moisture conditions.

It attacks the more fibrous and lignified parts of the cane, such as the rind and the nodes. Small, transverse tunneling characterizes its work. The larva in its latter instars is whitish with four longitudinal broken lines of purple-red. When full grown it is nearly an inch in length. The adult is straw-colored, resembling *Diatraea* but much smaller and less robust. The eggs are irregularly globular, slightly yellow and approximately 0.5 mm. in diameter.

From *Chilo* material taken from heavily infested cane the writer reared six specimens of *Chelonus* spp. From two *Chelonus* cocoons the larva of a hyperparasite was obtained. Fifteen specimens of a reddish Ichneumonid which attacks the full grown larva and the pupa were also reared. This parasite spins a silken cocoon and pupates between the remains of its host and the exit of the tunnel. The adult parasite emerges from the opening prepared by the larva for its own emergence as an adult. Although *Trichogramma* readily attacks the eggs of *Chilo* in the laboratory it is not likely that parasitism occurs to any extent in the field, since most of the eggs are probably deposited in crevices.

The species of *Diatraea* appear to be somewhat variable in distribution. It is probably responsible for about 25 per cent of the infestation in the joints. It also prepares the way for the invasion of the "red rot" fungus but its importance is mainly due to its killing of the young cane. *Diatraea* attacks the more succulent parts of the plant such as the "growing points" and internodes. The more vigorous succulent cane is

most highly infested since the adult females are attracted to dense stands. The cane is attacked only during the warm, humid months when growth is rapid.

The characteristic work of *Diatraea* in young cane is the formation of "dead hearts." In such cases a single borer causes the death of the plant. In old cane the tunnels extend lengthwise of the stalk and are about the diameter of a lead pencil.

The larva is usually whitish with transverse rows of black spots. The color of the adult varies from dusky gray to straw color. There are probably three generations a year. The adults appear in the spring about the middle of May.

The eggs are disc-shaped and overlap like shingles. They are deposited on the leaf surface near the midrib. One species deposits its eggs singly or in small masses of eight or less. The other species deposits large eggs in large masses. A female of the latter species in confinement deposited 440 eggs in two successive evenings. These eggs measured 1.5 mm. in length.

In the field both large and small species are parasitized by *Trichogramma minutum*. The mortality of *Trichogramma* in eggs of the large species, however, is very high. According to a report submitted by Mr. T. Vogliotti, parasitized eggs of this species rarely yield any adult *Trichogramma*.

In August 1929 the effect on *Diatraea* of liberating several million *Trichogramma* in the cane fields was observed by T. Vogliotti to be as follows:

In colonized fields—

435 eggs of large borer were 24.2 per cent parasitized.

444 eggs of small borer were 63.2 per cent parasitized.

In uncolonized fields—

289 eggs of large borer were 7.1 per cent parasitized.

177 eggs of small borer were 30.3 per cent parasitized.

No attempt was made to determine variations of the natural parasitism in uncolonized fields so no definite data on the effect of the liberation were obtained.

The leaf-surface area in a stand of sugar cane is many times greater than the land area occupied. *Trichogramma* must cover the leaf surface to find its host. To colonize it early in the season when moth eggs are comparatively scarce is useless. When the host eggs are fairly abundant as in the latter part of June and the natural parasitism is 1 per cent or more, the natural accretion over a large area is not likely to be affected

by the addition of more parasites. A possible means of initiating an earlier building up of the parasite population is the colonization of *Trichogramma* at egg concentration points during May and the first part of June. A series of strong lights or baits placed at intervals throughout the planting should result in heavy egg deposition in the vicinity of each attractant. Advantage could be taken of this phenomenon to colonize *Trichogramma* at such focal points and establish a more uniform parasitism throughout the planting, possibly earlier than normally occurs.

The only other parasite of *Diatraea* noted was a dexiid fly, the puparia of which was found in several canes. The old burrows of *Diatraea* are often used as nesting places by a green bee, *Augochlora aztica* (Vachal).

Upon completion of the laboratory, February 20th, production of *Trichogramma* was started. A great quantity of corn, shelled and on the ear, stored in the company's warehouse was found to be heavily infested with *Sitotroga cerealella*. The burlap method[1] was used in the collection of the moths. The initial stock of *Trichogramma* was obtained late in February from the eggs of the milkweed butterfly *Danaus menippe*. By the first of April the stock on hand amounted to 75,000.

A quantity of corn in the laboratory happened to be heavily infested with *Ephestia cautella* so its eggs were tested for use in mass production. They did not prove suitable although *Trichogramma* showed a marked preference for them in the presence of *Sitotroga* eggs.

The longevity of the adults developing on *Ephestia* eggs was considerably shorter than those reared on *Sitotroga* eggs. If any *Ephestia* eggs remain unparasitized, the larva from them feed on the surrounding eggs and spin a mass of webbing over the entire surface.

The shortest period of development from egg to adult was six days at temperatures from 80° to 90° F. and at an average humidity of about 75 per cent. This is a more rapid development than that obtained by the writer in 1928 at Saticoy using the California strain of *Trichogramma*. A series of generations was started with three females and at the end of seven weeks the progeny, composing the sixth generation, amounted to about 300,000. This multiplication was cut short because the supply of host eggs was inadequate.

On the West Coast of Mexico the control of cane-borers by the use of the native strain of *Trichogramma* does not appear probable since the two most destructive species are apparently not attacked to any extent. The utilization of *Trichogramma minutum* for the control of the sugar cane borer in Louisiana apparently has a greater chance of success.

[1]See page 601, Journal of Economic Entomology, Vol. 22, 1929.

THE PRESENCE IN GEORGIA OF *BRACON MELLITOR* SAY, A PARASITE OF THE COTTON BOLL-WEEVIL

By JULIAN H. MILLER and GEORGE F. CRISFIELD, *University of Georgia*

ABSTRACT

The weevil parasite, *Bracon mellitor*, has appeared this year in cotton fields in all parts of this State investigated. The first of these braconids were found in June, and then continuously until Sept. 15, when the work was temporarily halted. The number of weevil larvae destroyed in this manner ran as high as 18% in bolls and 35% in hanging squares in August in the field which was under constant observation.

This minute wasp, *Bracon mellitor*, has been reported by Hunter and Pierce[1] as occurring extensively in Texas and Oklahoma. There it has been found to have the same general distribution as the weevil, and until 1909 it was considered the most important parasite. It has been recorded from three species of Lepidoptera and from seven species of Curculionidae.

The parasite was first discovered in a cotton field near Athens, and later was found in quantity as far south as Waynesboro and as far north as Cornelia. The field near Athens has been under observation by the writers from the middle of May until September 15th. Cotton bolls and squares containing weevil larvae were picked from day to day, and the number of larvae parasitized were recorded. The habits of the Bracon were studied in the laboratory.

Cotton bolls and squares were placed under tumblers in contact with the Bracon wasps. The parasite made many attempts to penetrate the bolls and squares with its ovipositor, but was unsuccessful except where it encountered the weevil puncture. It deposits an egg in the cavity beside the weevil, and this hatches out within 3 to 6 days and the very young Bracon begins feeding. The weevil larva is completely destroyed within 9 to 12 days, and the wasp emerges as an adult in about 5 to 8 days more. The time for the complete life cycle varies with the season. In mid summer it is from 10 to 18 days, about 25 days in June, and much longer in the fall. The egg-hatching period has been continuous over the time of this study.

The activities of the parasite result in no harmful effect on the plants. No scars were observed on bolls placed under tumblers containing the parasite. With its ovipositor it penetrates only the weevil puncture.

[1]1912. W. D. Hunter and W. D. Pierce. The Mexican Cotton Boll-weevil: A Summary of the Results of the Investigation of this Insect up to December 31, 1911. Senate Document vol. 8, no. 305, p. 142.

In this field the cotton was dusted four times and the fallen squares were picked up, and still the writers were able to find large numbers of weevils during the entire period. The rainfall was heavy in June and July, but August was very dry with high temperatures. During the latter month many weevil larvae died in the squares due to the hot dry weather.

During June an average of 10% of the weevil larvae in the bolls and squares were parasitized, in July 14%, and in August and the first part of September about 18% in bolls and 35% in squares hanging on the plants. The per cent of parasitism was found to be greater in bolls and squares on the plant than in fallen ones during the entire period. The adult parasites were found chiefly around the top of the cotton plant.

The writers are experimenting with a method of breeding the parasites, and are also attempting to discover the conditions of hibernation in nature.

This Bracon parasite seems to be the most important one in Georgia. The present rate of weevil destruction from this source is of considerable value, but it is probable that it could be materially increased by breeding and distributing them.

NAPHTHALENE FUMIGATION AT CONTROLLED CONCENTRATIONS[1, 2]

By ALBERT HARTZELL and FRANK WILCOXON

ABSTRACT

A method of maintaining a constant concentration of naphthalene is described as an improvement on former methods of fumigation with this substance. A concentration of 0.008 lbs. of naphthalene per 1000 cu. ft. of air maintained for eight hours was found to kill red spider mite (*Tetranychus telarius*), cyclamen mite (*Tarsonemus pallidus*), the onion thrips (*Thrips tabaci*), and the black grain thrips (*Heliothrips, femoralis*) without injury to a number of plants that have proved intolerant to methods used previously.

INTRODUCTION

With the increased use of naphthalene as a greenhouse fumigant for the control of mites and thrips the question of a suitable method of volatilizing this material has arisen. Among the methods employed are broadcasting along the borders (9), volatilization with a lamp (4, 6), and finally the substitution of an electric hot plate (5). The importance

[1]Contributions from the Boyce Thompson Institute for Plant Research, Inc., Yonkers, New York, published at the expense of the Institute out of the order determined by the date of receipt of the manuscript.

[2]Herman Frasch Foundation for Research in Agricultural Chemistry Paper No. 4.

of maintaining a slow uniform rate of volatilization has been stressed by all investigators. Volatilization by means of lamps or electric hot plates has proved satisfactory for the more tolerant species and varieties, but certain plants are injured (5) by naphthalene vapor when these methods are used. The use of any method involving heat suffers under the disadvantage that a rather high concentration of naphthalene vapor is produced in the immediate neighborhood of the apparatus. This concentration will exceed the saturation value in parts of the greenhouse removed from the point of volatilization, and will cause deposition of naphthalene on the plants with consequent injury to those which are sensitive. If the naphthalene vapor could be introduced without heat, such a deposition would not occur, and injury would be reduced to a minimum. It would be necessary, of course, to supply the naphthalene vapor at a rate sufficient to compensate for leakage and to maintain the desired concentration for as many hours as were found needful for control. By passing a current of air over naphthalene at the same temperature as the greenhouse it should be possible to maintain almost any desired concentration up to that corresponding to the sublimation pressure of naphthalene, which would be the maximum attainable.

The Apparatus

In order to meet the requirements as outlined above, a naphthalene saturator was constructed in the form of an air tight rectangular metal box, 47 in. long, 35 in. wide, and 35 in. high. This box (Fig. 59) was divided into four compartments by three vertical baffles, and each compartment contained eight horizontal shelves. Air was drawn in at one end of the box, and travelled through each compartment in succession and was expelled through an opening in the top of the box at the opposite end from the point of entry. A motor-driven blower mounted on the top of the box served to draw the air through the saturator and expel it into the fumigation chamber. The air in passing over the shelves, which were each filled with a single layer of naphthalene balls, became partially saturated with naphthalene vapor. The final concentration of naphthalene in the air at a given temperature could be controlled either by varying the number of shelves filled with naphthalene balls, or by varying the speed of the blower. In these experiments the speed of the blower was constant, 1144 R. P. M., and the first mentioned method of control was used. With 24 shelves filled (which required 79 lbs. of naphthalene), and with an air velocity of 52 cu. ft. per minute, the time of contact of the air with the naphthalene was

approximately one minute and the area of contact was approximately 12-1/3 sq. ft., assuming the naphthalene balls to be spheres of uniform size. The number of pounds of naphthalene balls required to give satisfactory control of mites and thrips without injury to the host plants was determined by trial. In general, satisfactory results were obtained with 79 lbs. When 64 lbs. were used the control of cyclamen mite was possible with a 12-hour fumigation, but rather unsatisfactory results were obtained with red spider mite. With 93 lbs. considerable injury to the plants was experienced.

A greenhouse compartment situated between two larger sections was used as a fumigation chamber (Plate 20, Fig. A). The capacity of this chamber was 850 cu. ft. The height and width of the compartment was the same as the adjacent greenhouse sections and differed only from them in being about one-seventh their length. As the compartment was a unit in the same greenhouse range, the conditions of temperature, humidity, and light intensity were comparable to those of the adjoining greenhouses.

The naphthalene saturator described above was installed in the chamber and naphthalene free air was drawn into the saturator from an adjacent greenhouse section by means of a duct. Upon completing its path the air ladened with naphthalene vapor was deflected upward from the exhaust of the blower into the fumigation chamber. Opposite the saturator was a shelf built the same height as the greenhouse benches on which potted plants to be fumigated were placed. In very cold weather it was sometimes found that a small amount of naphthalene condensed on the panes of glass that constituted the roof of the chamber. When this happened it was desirable to remove the deposit since condensing moisture ladened with naphthalene dropped on the plants and caused injury.

Fumigations were made both day and night. In this study special emphasis was laid on testing the tolerance of plants that previous investigation had shown to be sensitive to naphthalene vapor. These were carefully checked with plants of the same age that had not been fumigated in order to note any possible delayed effect that the fumigation might have on plant growth. Plants infested with mites and thrips were fumigated and the results compared with data on the natural mortality of these species. Daylight fumigations were begun at 10 A. M. and continued until 4 P. M., a period of six hours. If an eight-hour period was desired the fumigation was terminated at 6 P. M. Night fumigations were run for a period of 15 hours, beginning at

5 P. M. and continuing until 9 A. M. the following morning. The plants were watered before fumigation as previous experience had shown that plants fumigated under dry conditions were liable to be injured.

Analysis of Greenhouse Air For Naphthalene

In greenhouse fumigation experiments few attempts to determine the actual concentration of the active agent are on record. Eddy and Geddings (1) give data on the determination of hydrogen cyanide in a

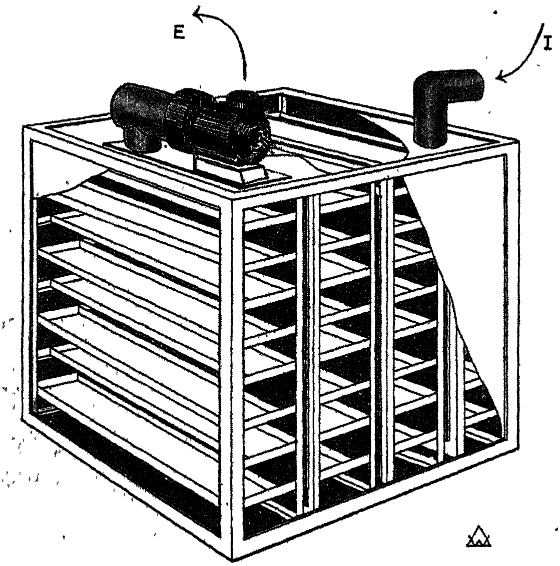


Fig. 59.—Naphthalene saturator consisting of a galvanized iron box containing 32 horizontal shelves separated by baffles. *I*. The naphthalene free air is drawn in at this point from an adjacent greenhouse section. *E*. The air ladened with naphthalene is expelled at this point from the motor-driven blower after its pasage over the shelves filled with a single layer of naphthalene balls.

fumigation chamber. It was considered desirable to attempt to determine the naphthalene concentration in the greenhouse air during a fumigation, although it was known that this was very small. The

method adopted was that of Gair (3). Air was drawn by a water pump through an absorption train consisting of two gas washing bottles each containing 175 cc. of acetic acid of sp. g. 1.044, followed by a third bottle containing 150 cc. of saturated picric acid solution. The air was finally passed through a small laboratory flow meter. At the conclusion of a run, the naphthalene was precipitated as the picrate by the addition of 500 cc. of saturated picric acid solution as described by Gair. The naphthalene picrate was filtered through a weighed Gooch crucible, dried in a desiccator and weighed. From the weight obtained, and the volume of air measured by the flow meter, the concentration of naphthalene vapor in the greenhouse air could be calculated. Owing to the small concentration, it was necessary to continue the run over several fumigation periods in order to obtain a weighable amount of naphthalene picrate. The result thus obtained is an average value, and required four or five days for a single determination. One such experiment gave a concentration of naphthalene of 0.0076 lbs. per 1000 cu. ft., and a subsequent determination gave 0.0085 lbs. per 1000 cu. ft. The average temperatures during these experiments were 86°F. and 89°F. respectively. A determination in which the sample was taken at the point of exit from the saturator gave a concentration of 0.0128 lbs. per 1000 cu. ft. Roark and Nelson (8) have published tables showing the amount of naphthalene vapor in saturated air at various temperatures. From the value for 86°F. which is given as 0.06 lbs. per 1000 cu. ft., it appears that in our experiments the air in the neighborhood of the plants was approximately 13% saturated with naphthalene vapor. This concentration if maintained for a sufficient length of time, gave satisfactory control of mites and thrips with less injury than previous methods had shown.

By weighing the charge of naphthalene before and after a series of fumigations it was found that the rate of loss per hour was 0.0884 lbs. This includes any loss that might take place between periods of fumigation.

Plant Tolerance

It has been shown in previous publications (4, 5) that certain species and varieties of plants are injured by the lamp and hot plate methods of volatilization. This was found to be true even with fumigations made at night and with amounts not exceeding two ounces per 1000 cu. ft. of greenhouse space. Of 150 species and varieties tested by the above methods more or less foliage injury resulted to forty-two. A list of these intolerant plants follows:

Capsicum annuum var. longum (pepper)	Nicotiana suaveolens
Fagopyrum esculentum (buckwheat)	Nicotiana sylvestris
Fuchsia speciosa	Nicotiana tabacum
Glycine max (soy bean)	var. gigantia
Linaria sp.	var. purpurea
Lycopersicum esculentum (tomato)	Nicotiana trigonophylla
Lythrum salicaria var. roseum	Nycterinia capensis
Magnolia sp.	Oxalis sp.
Martynia proboscidea	Papaver sp. (poppy)
Matricaria alba	Papaya sp.
Maurandia sp.	Pelargonium sp. (geranium)
Nemesia sp.	Plantago major (broad leafed plantain)
Nemophilia sp.	Philadelphus sp. (mock orange)
Nicotiana langsdorffi	Physalis sp.
Nicotiana longiflora	Raphanus sativus (radish)
Nicotiana nudicaulis	Rose var. Button hole
Nicotiana paniculata	Ribes nigrum (black currant)
Nicotiana plumbaginifolia	Schizanthus wisetonensis
Nicotiana quadrivalvis	Trifolium pratense (red clover)
Nicotiana repanda	Tropaeolum majus (nasturtium)
Nicotiana rustica	Vitis vinifera (grape)
Nicotiana sanderae	

While it was not found feasible to test every species and variety in the above list with fumigations at controlled concentrations, it was found possible to test the more common species grown in greenhouses and in addition a number of important plants not included in the above list. Reference to Table 1 will show that of a total of 32 species and varieties of plants fumigated, only three species were found to be intolerant, namely buckwheat (*Fagopyrum esculentum*), soy bean (*Glycine max*), and Tabasco pepper (*Capsicum annuum* var. *conoides*). The last named plant was only slightly injured, the very oldest leaves turning yellow and falling off. Other varieties of pepper were uninjured. Seedling buckwheat plants were found to be by far the most sensitive of the three (Plate 21, Figs. A and B). A comparison of the above list of intolerant plants with Table 1 shows that of a dozen species and varieties which were found to be intolerant to naphthalene fumigation by the lamp and hot plate methods, only two were severely injured by our improved method. Included in these tests were such important greenhouse plants as pepper (*Capsicum annuum*) (five varieties), tomato (*Lycopersicum esculentum*), *Oxalis* sp., geranium (*Pelargonium* sp.), radish (*Raphanus sativus*), rose seedlings and nasturtium (*Tropaeolum majus*), which could not be fumigated with safety by the older methods, but which were found to be tolerant when fumigated at a properly

controlled concentration. Irish Cobbler, Green Mountain, and Bliss Triumph potatoes (*Solanum tuberosum*), egg-plant (*Solanum melongena* var. *esculentum*), turnip (*Brassica rapa*), *Bryophyllum* sp., *Calendula officinalis*, China aster (*Callistephus chinensis*), *Centaurea imperialis*, cucumber (*Cucumis sativus*), *Datura stramonium*, carrot (*Daucus carota* var. *sativa*), Sudan grass (*Holcus sudanensis*), Turkish tobacco (*Nicotiana tabacum*), bean (*Phaseolus vulgaris*), *Sedum* sp., white clover (*Trifolium repens*), and wheat (*Triticum aestivum*) were also found to be tolerant. Even cyclamen plants in flower were not injured (Plate 20, Figs. B and C). It should be noted that all these plants were fumigated in daylight at temperatures ranging from 72° F. to 100°F., during both cloudy and sunny weather and that no injury resulted even with concentrations slightly higher than that found necessary to kill mites and thrips. A careful comparison of fumigated plants with their corresponding check plants which were not fumigated, showed no evidence of stunting or of delayed injury.

The writers' previous experience had been unfavorable with daylight fumigations in bright sunlight and with the higher range of temperatures. Apparently the slower uniform rate of volatilization of naphthalene by this method results in a concentration considerably below the tolerance limit to foliage, which is in direct contrast to the uneven rate obtained by means of the hot plate and lamp methods with the resultant injury to foliage. The chief disadvantage of daylight fumigation is the difficulty of keeping the temperature from rising too high; this especially is true with plants such as cyclamen and potato which are normally grown at lower temperatures. It is interesting to note in this connection that a concentration which would injure young buckwheat plants but which would not injure six-inch tomato plants (var. Bonny Best) was found to be suitable for all species and varieties as shown in Table 1, with the exception of buckwheat, soy bean, and Tabasco pepper.

TABLE 1. EFFECT OF NAPHTHALENE FUMIGATION AT CONTROLLED CONCENTRATION ON HOST PLANTS

Name of Plant	Number of Plants	Height of Plants Inches	Daylight Fumigation 6 hours: Temperature °F.	Relative Humidity Percent
Brassica rapa (turnip)	40	4	82–100	70
Bryophyllum sp	5	6	82–100	70
Calendula officinalis	5	6	78–90	67
Callistephus chinensis (China aster)	24	4	68–98	68
Capsicum annuum var. abbreviatus	36	12	82–100	70
var. acuminatum	36	10	82–100	70
var. cerasiforme (red cherry pepper)	36	8	82–100	70

TABLE 1—*Continued*

var. conoides (Tabasco pepper)*	36	15	82–100	70
var. fasciculatum (Red Japan cluster pepper)	36	12	82–100	70
var. grossum (bell pepper)	36	12	82–100	70
Centaurea imperialis	5	6	78–90	67
Cucumis sativus (cucumber)	10	4	86–100	48
Cyclamen indicum	15	10	80–100	50
Datura stramonium	30	12	80–100	78
Daucus carota var. sativa (carrot)	50	3	68–98	68
Fagopyrum esculentum (buckwheat)*	200	10	82–100	70
Fuchsia speciosa	5	15	78–90	67
Glycine max (soy bean)*	200	6	80–100	78
Holcus sudanensis (Sudan grass)	100	12	68–98	68
Lycopersicum esculentum (tomato)	50	6	76–86	68
Nicotiana tabacum	24	—	82–100	70
Oxalis sp.	500	—	82–100	70
Pelargonium sp. (geranium)	5	12	78–90	67
Phaseolus vulgaris (bean)	10	—	72–	58
Physalis francheti	10	4	82–100	70
Prunus persica (peach)	10	24	80–84	56
Raphanus sativus (radish)	50	4	82–100	70
Rose seedlings	20	6	81–95	64
Sedum sp.	5	6	76–96	50
Solanum melongena var. esculentum (egg-plant)	10	—	68–98	60
Solanum tuberosum var. Irish Cobbler potato	12	—	78–100	56
Solanum tuberosum var. Bliss Triumph	40	—	78–100	56
Trifolium pratense (red clover)	200	8	82–100	70
Trifolium repens (white clover)	200	4	82–100	70
Triticum aestivum (wheat)	100	4	80–100	50
Tropaeolum majus (nasturtium)	50	8	82–100	70
			Night fumigation 15 hours	
Capsicum annuum var. abbreviatus	36	6	72–80	78
var. acuminatum	36	6	72–80	78
var. cerasiforme (red cherry pepper)	36	6	72–80	78
var. conoides (Tabasco pepper)*	36	6	72–80	78
var. fasciculatum (Red Japan cluster pepper)	36	6	72–80	78
var. grossum (bell pepper)	36	6	72–80	78
Glycine max (soy bean)*	100	4	76–86	68
Lycopersicum esculentum (tomato)	24	18	72–80	78
Nicotiana tabacum (tobacco var. Turkish)	24	3	72–86	68
Oxalis sp.	200	—	72–80	78
Trifolium pratense (red clover)	200	—	72–80	68

*Foliage injured.

CONTROL OF GREENHOUSE PESTS

It was found during the course of this investigation that naphthalene fumigation would control cyclamen mite (*Tarsonemus pallidus*) on various greenhouse plants such as cyclamen and pepper. The minimum

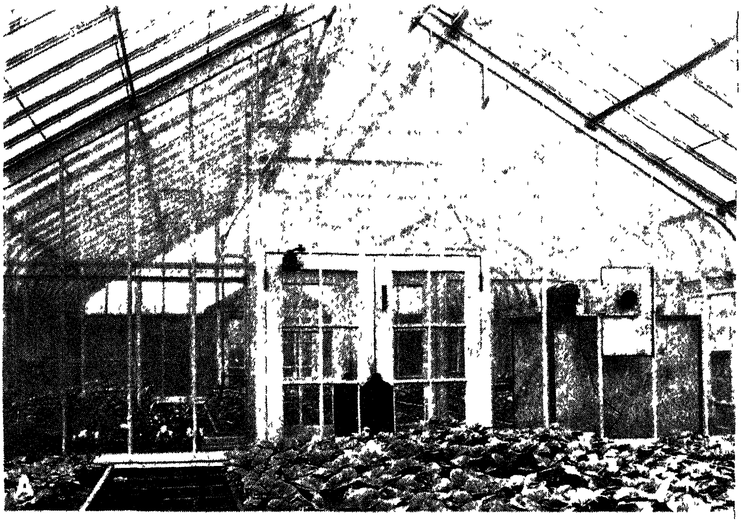
period of exposure necessary to obtain satisfactory control was found to be six hours when 79 lbs. of naphthalene was used in the saturator. It has been shown elsewhere (3) that the red spider mite[1] (*Tetranychus telarius*), the onion thrips (*Thrips tabaci*) and the black grain thrips (*Heliothrips femoralis*) are controlled by naphthalene fumigation. As indicated in Table 2, it required a minimum of eight hours to obtain a satisfactory control of thrips and of the red spider mite. Thus it follows that the three species could be controlled by eight-hour fumigations and if the plants were infested with the cyclamen mite alone, a six-hour fumigation was sufficient or the amount of naphthalene could be reduced to 64 lbs. and the period lengthened to 12 hours.

TABLE 2. PERCENTAGE CONTROL OF GREENHOUSE PESTS TO NAPHTHALENE VAPOR

Exposure to naphthalene vapor	Temperature			Red Spider mite		Cyclamen mite		Thrips: Thrips tabaci		Thrips: Heliothrips femoralis	
	Maximum	Minimum	Relative humidity	Number of specimens	Per cent control	Number of specimens	Per cent control	Number of specimens	Per cent control	Number of specimens	Per cent control
Hours	°F.	°F.	Per cent								
6	84	80	56	—	—	500	100	200	100	500	96.1
6	100	78	46	171	74	500	100	—	—	—	—
8	100	80	50	187	94.1	241	100	—	—	—	—
8	100	80	63	267	99	500	98.6	—	—	—	—
8	100	78	70	525	97.3	—	—	—	—	—	—
8	75	74	72	393	94	500	99	502	99	500	99

The question of the resistance of the various stages of the red spider mite to naphthalene vapor has arisen. Read (8) has shown by laboratory experiments that it required at least eight hours' exposure of the eggs to a saturated atmosphere of naphthalene to prevent hatching; at 60°F. they were not killed when exposed for a period of 30 hours. To determine the effect of this method of fumigation on hatching of eggs, leaves from plants fumigated for eight hours at an average temperature of 86°F. were placed in petri dishes and counts of larvae (first stage) made at various intervals of time. A similar series of leaves from unfumigated plants served as a check. Table 3 shows the number of larvae on these leaves in the control and fumigated series. The temperature during this period was 71°F. It will be observed that fumigation by this method has had a considerable effect on the hatching of the eggs. In the control 21% of the eggs had hatched after 120 hours while in the case of the fumigated series only about 3.5% had hatched in this time.

[1]The term red spider mite is used in preference to the term red spider, following the suggestion of the Committee on Nomenclature of the American Association of Economic Entomologists.

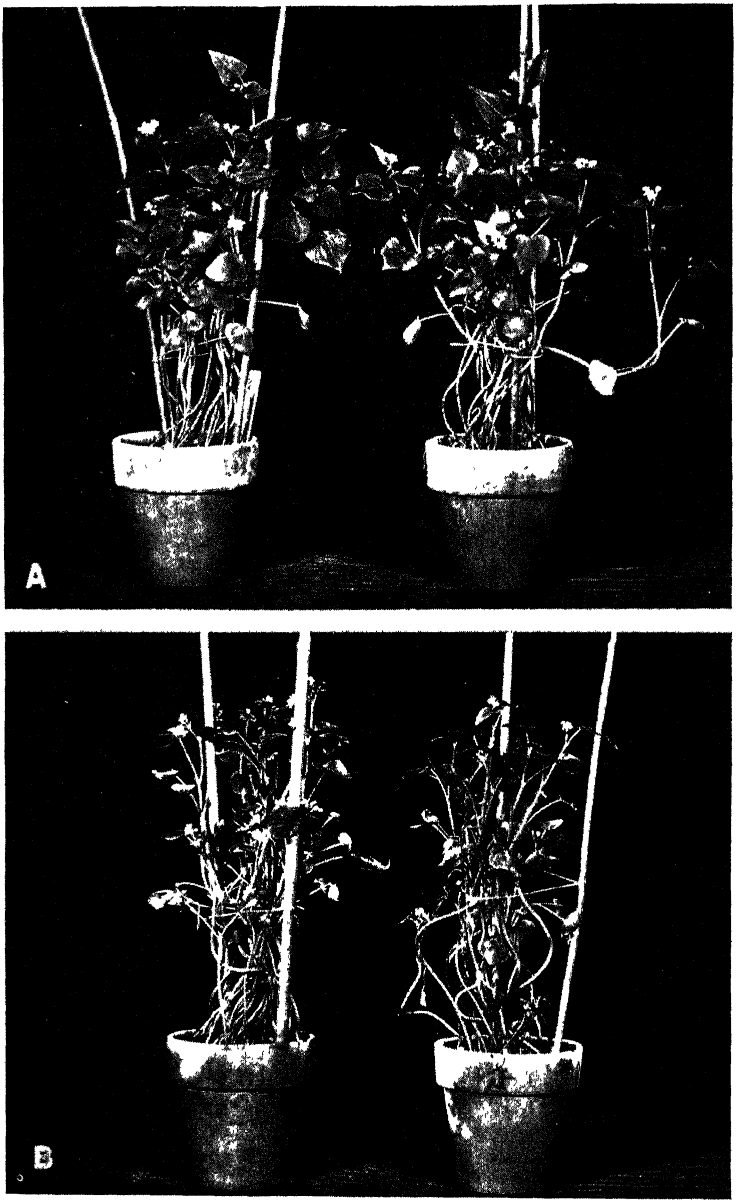


A. Fumigation chamber situated between two greenhouse sections with naphthalene saturator in place. Note the plants to the left to be fumigated.

B. Cyclamen plants in flower that have been fumigated with naphthalene showing no injury to flowers or foliage.

C. Cyclamen plants that were badly infested with cyclamen mite that have been fumigated with naphthalene with no foliage injury.

Plate 21



A. Buckwheat plants unfumigated.

B. Buckwheat plants that have been fumigated with naphthalene showing foliage injury. Buckwheat is very intolerant to naphthalene fumigation and was found to be one of a few plants unsuitable for fumigation with naphthalene.

TABLE 3. EFFECT OF NAPHTHALENE FUMIGATION ON HATCHING OF EGGS OF RED SPIDER MITE

Hours After Fumigation	Fumigated Number of eggs	Number of Larvae (First Stage)	Control Number of Eggs	Number of Larvae (First Stage)
24	964	11	394	16
48	—	20	—	20
72	—	30	—	72
120	—	34	—	84

A study of the comparative resistance of the larva, protonymph, deutonymph, and the adult female to naphthalene vapor showed that there was a slight increase in resistance on passing from the larva to the adult and, furthermore, that the last two stages exhibit a significant difference in resistance when compared with the first two stages. When the X^2 test for homogeneity (2) was applied to the data on the first and second stages grouped together as compared with the third and adult stages grouped similarly, the difference was found to be significant with odds greater than 100 to 1. The total number of individuals used in this comparison was 4204.

The possibility of recovery of the red spider mite after fumigation was considered. To test this point leaves from fumigated plants were kept in petri dishes under observation for a period of 120 hours and counts of living individuals exclusive of the eggs and first stages, were made. Out of a total of 380 individuals 15 were alive 24 hours after fumigation and 11, 120 hours after fumigation. It appears, therefore, that the percent recovery in the 120 hours following an eight-hour fumigation was very low, while the mortality in the check was less than two percent.

DISCUSSION

In the case of a toxic agent, where the concentration necessary to kill is not far removed from that which will injure the host plant, it is desirable to use the material at a constant concentration. If the concentration fluctuates widely during the experiment, injury may be experienced, even though control is incomplete. Naphthalene as a fumigant seems to be a case of this kind. The method of fumigation described in this paper provides an almost automatic control of the actual concentration, and also permits an experimental determination of the best time and concentration to use for a given purpose. The fact that by this method it was possible to fumigate plants that had previously proved intolerant to naphthalene, suggests that a more careful study of compounds already in use may be as valuable as a search for new toxic agents hitherto untried. The writers' experience with naphthalene as a

greenhouse fumigant as applied by the hot plate and lamp methods has not been entirely satisfactory with mixed plantings. The difficulty of removing intolerant plants prior to fumigation greatly limits its use. The method described above has not yet been tested for large scale use but the principle involved, i.e., the use of a constant concentration of naphthalene throughout the fumigation period appears to be a step in the right direction.

Summary

A method of fumigating with naphthalene is described which permits a constant concentration of naphthalene to be maintained in the fumigation chamber throughout the experiment.

It has been established that a concentration of naphthalene 0.008 lbs. per 1000 cu. ft. if maintained for eight hours at an average temperature of 87°F. and an average relative humidity of 60% will give satisfactory control of the red spider mite, cyclamen mite, and thrips.

No injury was observed in these experiments to any plant except buckwheat, soy bean, and one variety of pepper. Fumigation was carried out in the daytime as readily as at night by this method.

A series of plants that had proved intolerant to naphthalene fumigation by previous methods was successfully fumigated by the method described.

Literature Cited

1. Eddy, C. O. and Geddings, E. N. Determining Hydrocyanic Acid Gas Concentration in Fumigation Experiments. Jour. Econ. Ent., 22:366–378. 1929.
2. Fisher, R. A. Statistical Methods for Research Workers. pp. 77–100, 1925, Oliver and Boyd, London.
3. Gair, C. J. D. Estimation of Naphthalene in Coal Gas. Jour. Soc. Chem. Indus. 24:1279–1281. 1905.
4. Hartzell, A. Naphthalene Fumigation of Greenhouses. Jour. Econ. Ent. 19:780–786. 1926.
5. ——— Tolerance of Different Species and Varieties of Plants to Naphthalene Vapor. Jour. Econ. Ent., 22:354–359. 1929.
6. Parker, T. On the Control of Red Spider by Means of Naphthalene Vaporized Over a Special Lamp. Ann. App. Biol., 15:81–89. 1928.
7. Read, W. H. Entomological Report. Red Spider Investigations (c) Fumigation. Nursery and Market Carden Indus. Develop. Soc. Ltd. Exp't'l. and Res. Sta. 13th Ann. Rept., 1927:73. 1928.
8. Roark, R. C. and Nelson, O. A. Maximum Weights of Various Fumigants which can Exist in Vapor Form in a 1000 Cubic Foot Fumigation Chamber. Jour. Econ. Ent., 22:381–387. 1929.
9. Speyer, E. R. Entomological Investigations. Nursery and Market Garden Indus. Develop. Soc. Ltd. Exp't'l. and Res. Sta. 10th Ann. Rept., 1924:82–104. 1925.

THE COMPARATIVE INSECTICIDAL VALUE OF DIFFERENT SPECIES OF DERRIS[1]

By E. R. deOng[2], *Mills Bldg., San Francisco, Calif.*

ABSTRACT

A comparison of the insecticidal values of extracts and powders made from identified species of the genus *Derris*, in which all were found valuable.

The insecticidal value of various tropical plants belonging to the genus *Derris* (family Papilionaceae, tribe Dalbergieae, subtribe Lonchoecarpinae) is the subject of certain recent papers. With few exceptions, no attempt is made to identify specifically the plants used in the reported experimentation. McIndoo, Sievers and Abbott (1)[3] used some half-dozen species, and in the end find that only *D. elliptica* (Roxb.) Benth. and *D. uliginosa* Benth. are "satisfactory for insecticidal purposes." But, while they employed in much of their work their own macerations of "tuba," or "toeba," received from Java as roots of *elliptica*, many of their data are derived from the use of a fine powder obtained in Malayan market places,—the ground root of a species described as "probably *D. elliptica*." Wells, Bishopp and Laake (2 p. 91) state that the material used "is supposed to be from *Deguelia* (*Derris*) *elliptica*." The material used by Tattersfield and Roach (3) is the same as that reported upon by Fryer, Stenton, Tattersfield and Roach which is stated (4 p. 22) to be "commercial samples of *Derris elliptica*." The material used by deOng and White (5) was also a commercial sample. Since species determination by such an authority as E. D. Merrill was made possible

[1]The following list of synonyms is taken from Merrill's "Enumeration of Philippine Flowering Plants. 2:299–302. 1923

Derris elliptica Roxb.	*Derris heptaphylla* (Linn.) Merr.	*Derris trifoliata* Lour.
Galedupa elliptica Roxb.	*Sophora heptaphylla* Linn.	*Robinia uliginosa* Roxb.
Galactia terminaliflora Blanco	*Pongamia sinuata* Wall.	*Dalbergia heterophylla* Willd.
Cylista piscatoria Blanco	*Pterocarpus diadelphus* Blanco	*Galedupa uliginosa* Roxb.
Millettia splendidissima Vidal	*Derris sinuata* Thwaites	*Pongamia uliginosa* DC.
Millettia piscatoria Merr.	*Derris thyrsiflora* F.-Vill.	*Pterocarpus frutescens* Blanco
	Derris floribunda Naves	*Derris uliginosa* Benth.
	Derris diadelpha Merr.	*Derris diadelphus* Naves

[2]The following data were secured in experiments performed at the University of California but prepared for publication after the author had resigned from this institution.

[3]Reference is made by number (italics) to "Literature Cited."

only by the aid of foliage in addition to roots and stems, it would seem that doubt might be cast on the determination of commercial supplies and possibly some of the variations reported by certain investigators might be due to this cause. With the most generous recognition, therefore, of the research of different workers, it has nevertheless appeared desirable to pursue inquiry further in the light of accurate identification of all the species of Derris used, without exception. To this additional investigation there is an increased incentive in the fact that several species of Derris grow commonly in the Philippine Islands, where they are highly available both for export as raw material and for local manufacture into exportable insecticides.

That the writer has had peculiar opportunity for such study of Derris is due to the encouragement of E. D. Merrill, Dean of the College of Agriculture, University of California, late Director of the Bureau of Science at Manila and a foremost authority on the botany of the Philippine and Malayan islands. Through Dean Merrill's assistance, specimens of four species of *Derris* were obtained from the Bureau of Forestry of the Philippine Islands, identified, and tested for insecticidal value. These species are *Derris elliptica* (Roxb.) Benth., *D. heptaphylla* (Linn.) Merr. (*D. sinuata* Thw.), *D. polyantha* Perk., and *D. trifoliata* Lour. (*D. uliginosa* Roxb.). The experimental material was collected through the immediate kindness of Arthur F. Fischer, Director of Forestry, Manila, P. I., and shipped to Berkeley, California. No attempt was made to preserve the insecticidal principle in transit or storage, the specimens being baled and shipped in rough packages. The cut ends of the twigs, upon arrival frequently showed a white gummy exudate, presumably the dried sap.

From the four species on hand, preparations were made in the form of ether extract (obtained by use of a Soxhlet extractor) of water and alcoholic extracts, and of finely ground powder made direct from the dry raw material. With these, insecticidal tests were made as detailed below. In certain experiments, as indicated, the insecticide used had been prepared from roots; in others, from stems; in others, from trunks.[4]

[4]A study of insecticidal values given in the appended records reveals a much lower toxicity than that claimed for the roots of *D. elliptica* as a fish poison. An unpublished report of the Philippine Forest School Notes, loaned by H. E. Woodworth, formerly Professor of Entomology, College of Agriculture, University of the Philippines, states: "*D. elliptica* ('tuba') roots are tied into bundles of convenient size and length which are then crushed at one end and dipped into the water. The soapy substance given off poisons the fish at dilutions of 1 to 350,000 or 500,000. The toxicity may be increased by placing the roots in the mud several days before using." Such a report leads to the thought that the toxicity of the material may be impaired by drying and by time used in shipping, and that a more toxic extract might be obtained from the fresh material.

EXTRACTION METHODS (3). Sections of the root (or trunk, or stem) of a given species were ground in a mill and extracted in a Soxhlet extractor on a water bath. After three to four hours of extraction, the ether was removed from the apparatus and placed in a flask connected to a condenser and receiving flask. Most of the ether was then distilled off (again on a water bath), a residue of 15–20 cc. being left. (The bath method is used to prevent decomposition of the Derris extract, which takes place at rather low temperatures.) This residue together with the rinsings obtained from the emptied flask with fresh ether, was now evaporated on a water bath, while being constantly stirred. The beaker was removed when the temperature reached 60° C. or when no more bubbles were evolved on stirring. On cooling, the dark green liquid or extract solidified, permitting its amount to be determined as tabulated below. This done, the extract was remelted by immersion of the beaker in hot water, at which time sufficient pyridine or alcohol was added to prevent solidification during the process of cooling. Thus liquefied, it was diluted as desired. It was possible to use less pyridine or alcohol by adding, to the melting extract, a small quantity of a sodium oleate soap, which addition is likely to be necessary if the extract on precipitating tends to clot.

The extracts as tabulated below were made from air-dry specimens which were ground as required, and the percentages as given in Table 1 were based on the weights of the air-dry specimens. These percentages would probably have been higher if an extraction period longer than three to four hours had been allowed, or if more finely ground material had been used.

TABLE 1. ETHER EXTRACTS FROM *Derris* SPP.

Species	Amount of Sample Used *Gm.*	Extract *Gm.*	Per cent Extract
D. elliptica roots	18.249	.343	1.87
trunk	23.670	.536	2.26
D. heptaphyllata roots	17.137	.717	4.18
D. polyantha roots	21.708	.687	3.17
trunk	16.755	.498	2.97
D. trifolia roots	17.803	.415	2.23
trunk	21.571	.703	3.26

INSECTICIDAL TESTS. The solidified extract was dissolved both in pyridine and alcohol. These solutions were then diluted in the ratio of 98 per cent of water to 2 per cent of the original extract. The derris extract in the pyridine solution precipitates to a certain extent when dissolved in water. The alcoholic solution would clot when diluted with water unless a small amount of a sodium oleate soap were added.

Small dishes were filled with the diluted extract, and beetles (*Hippodamia convergens* Guerin) immersed in the solutions. Every ten minutes those that showed no activity were removed. The individuals in which no signs of life appeared before the next ten minutes had elapsed, were considered dead. The checks consisted of pyridine and alcohol solutions of approximately the same concentration as that of the extracts.

Tables 2 and 3 give the rate of mortality on beetles for varying concentrations of *Derris trifoliata* and *D. polyantha*. The solidified ether extract of the species concerned was dissolved in ethyl alcohol containing approximately ½ per cent of a sodium oleate soap. Finding that it was possible to kill the beetles at low concentrations of the extract, a second series was run as shown in Table 3. Pyridine solutions of these same extracts were tried but at 0.10 per cent concentration no difference could be distinguished between the checks and the extracts, hence it was concluded that the alcoholic solution gave a more delicate indication of the insecticidal value of the species being tested.

Specimens of the roots of *Derris trifoliata*, *D. polyantha*, *D. heptaphylla*, and *D. elliptica* were ground very fine and the dust applied to rose aphid, *Myzus rosarum* Walker, with results as shown in Table 4. Ground sections of the stems of these four species were then applied pure to the woolly apple aphis, *Eriosoma lanigera* (Hausm.), and after thirty days' exposure it was found that *D. elliptica* and *D. trifoliata* had killed 100 per cent, with 55 per cent mortality for *D. heptaphylla*, and 84 per cent for *D. polyantha*, the check having a natural mortality of 48 per cent.

TABLE 2. TOXICITY TO BEETLES OF EXTRACTS FROM *D. trifoliata* (TRUNK) AND *D. polyantha* (ROOTS)

Concentration of Extracts	Time in Minutes				
D. *trifoliata* (trunk)	20	30	40	90	150
%	%*	%	%	%	%
2.0	—	66	100	—	—
1.0	—	92	100	—	—
0.5	—	85	100	—	—
0.4	18	72	100	—	—
0.2	45	65	—	100	—
0.1	25	48	—	100	—
Check (Alcohol 95%)	15	—	44	—	91
D. polyantha (roots)					
0.4	70	100	—	—	—
0.2	20	100	—	—	—
0.1	10	30	60	100	—
Check (Alcohol 95%)	—	—	—	—	30

*Percentage dead.

TABLE 3. TOXICITY TO BEETLES OF EXTRACTS* FROM *D. elliptica* (TRUNK), *D. polyantha* (ROOTS), AND *D. trifoliata* (TRUNK)

Species	Time in Minutes 10 %**	15 %	20 %	30 %	35 %	45 %	55 %	65 %	75 %	85 %	95 %	105 %	115 %	125 %	135 %
D. elliptica.... (trunk)	5	16	21	26	42	53	53	74	84	95	100	—	—	—	—
D. polyantha... (roots)	5	5	5	5	10	20	29	43	43	72	91	100	—	—	—
D trifoliata.... (trunk)	5	5	10	10	10	10	14	19	24	33	43	62	76	86	100
Check (Alcohol 95%)	5	5	5	5	5	5	5	10	10	15	29	29	33	33	33

*The concentration of the extracts used in this table was 0.1 per cent.
**Percentage dead.

TABLE 4. TOXICITY TO ROSE APHID* OF THE GROUND DUST** OF *Derris* SPP.

Species	Number of Insects Used	Percentage Dead %	Length of Exposure
D. trifoliata (roots)....................	120	63	4 days
D. polyantha (root)....................	137	70	4 days
D. heptaphylla (roots)..................	131	92	4 days
D. elliptica (roots)....................	111	86	4 days

**Myzus rosarum* Walker.
**These were very finely ground undiluted dusts of the species indicated.

TABLE 5. REPELLING AND TOXIC EFFECT OF EXTRACTS* FROM *Derris* SPP. ON THE CATERPILLAR, *Euphydryas chalcedona*

Species	Number of Larvae Used	Larvae Dead %	Larvae Pupated %	Amount of Foliage Eaten %	Remarks
D. elliptica.... (roots)	34	33	5	2	Unsprayed growing tip completely eaten.
D. polyantha (trunk)	20	15	35	5	
D. trifoliata (roots)	22	13	4	10	
D. heptaphylla (roots)	26	4	4	40	
Check	19	6	—	100	Leaves and part of stem consumed

*Solutions containing 2 per cent by weight of the ether extracts of the species indicated.

Extracts of *D. trifoliata*, *D. polyantha* and *D. heptaphylla* were made by soaking chips and coarse powder of the roots and trunks of the above species in water and 95 per cent ethyl alcohol. These extracts had no effect on rose aphis.

The repelling action of the ether extracts of *D. elliptica* (roots), *D. polyantha* (trunk), *D. trifoliata* (roots), and *D. heptaphylla* (roots) was then tried on varying ages of the larvae of the butterfly *Euphydryas*

chalcedona (Dbldy. & Hew.), Table 5. Solutions containing 2 per cent by weight of the extract from the species indicated were sprayed on the foliage and stems of *Scrofularia californica* (the common host of this insect) and as soon as it was dried the larvae were placed upon the twigs. Feeding ceased, in most instances, after a few attempts to consume the sprayed foliage. A small percentage of the caterpillars was killed and the more mature pupated. The larvae were confined with these twigs for eight days but there was no appreciable increase in feeding during this period except in one cage the growing tip was consumed. The unsprayed twigs, however, were almost entirely consumed during this period, not only the foliage but much of the stems being eaten. The repelling effect apparently lasted during the entire time that the cuttings could be kept alive in the laboratory.

Conclusions and Summary. Identified specimens of *Derris elliptica* Benth., *D. heptaphylla* Merr., *D. polyantha* Perk. and *D. trifoliata* Lour. were tested comparatively to determine their insecticidal values. Experiments were made with ether extracts of the respective species, dissolved both in alcohol and pyridine and with pure dusts made by grinding specimens of different parts of the plants.

All species of *Derris* tested showed sufficient insecticidal value to warrant commercial experimentation both with ether extracts and the ground powder. *Derris elliptica* showed a certain degree of superiority over the other species tested but not such as to warrant classifying the latter as inefficient. Valuable inherent insecticidal properties were found in all species tested (1) as toxic agents in immersion tests, (2) as aphidicides, and (3) as a repellent for a species of defoliating caterpillar. These toxic values were found to be present in all parts of the plants tested although in slightly varying amounts.

Literature Cited

1. McIndoo, N. E., A. F. Sievers and W. S. Abbott. 1919. Derris as an insecticide. Jour. Agr. Research 17:179–200.
2. Wells, R. W., F. C. Bishopp and E. W. Laake. 1922. Derris as a promising insecticide. Jour. Econ. Entom. 15:90–95.
3. Tattersfield, T. and W. A. Roach. 1923. Chemical properties of *Derris elliptica* (tuba root). Ann. Applied Biol. 10:1–17.
4. Fryer, J. C. F., R. Stenton, T. Tattersfield, and W. A. Roach. 1923. A quantitative study of the insecticidal properties of *Derris elliptica*. Ann. Applied Biol. 10:18–34.
5. deOng, E. R. and L. T. W. White. Further studies of derris as an insecticide. Jour. Econ. Entom. 17:499–501.

THE RELATION OF EVAPORATION TO KILLING EFFICIENCY OF SOAP SOLUTIONS ON THE HARLEQUIN BUG AND OTHER INSECTS[1]

By B. B. FULTON, *N. C. State College*

ABSTRACT

Tests of various known contact insecticides on the harlequin bug, *Murgantia histrionica*, brought out the fact that certain soap solutions are very effective but only under conditions of low evaporation. Further experiments under known rates of evaporation show that the efficiency of soap solution is indirectly proportional to the rate of evaporation. The addition of hygroscopic substances did not materially increase the effectiveness. Tests with several kinds of soap and two other species of insects show that the relationship is probably a general one.

A series of preliminary experiments which will not be detailed here revealed the fact that the harlequin bug is unusually resistant to all of the common contact insecticides. The technique finally adopted for testing various insecticides was to dip or spray a given number of bugs, usually ten, confined in a small wire screen cylinder. After the excess liquid was blown off the insects were retained in the cage for not more than a day to check up on the results. Untreated insects from the same lot were confined in a similar cage as a control.

With this method a 6% solution of resin fish oil soap killed a higher percentage of harlequin bugs than any of the common insecticides including a number of commercial brands of nicotine, derris, pyretherum, and miscible oils used at the highest concentration recommended for any insect. Combinations of the other materials with soap did not increase the effectiveness. If the soap solution was diluted by the addition of other spray materials, the effectiveness was reduced about in proportion to the concentration of soap.

Following this lead other kinds of soap were tried in the same way. By testing a series of commercial soaps obtained at a grocery store it was discovered that many of them were more effective for harlequin bug than the resin fish oil soap. The strength of solutions was reduced to 2%. As a general rule the white soaps proved better than the strong yellow soaps.

During the course of these experiments it became evident that results obtained on different days were conflicting, and the differences seemed too great to be accounted for as experimental error. A small field test was then made with a 2% solution of one of the more promising brands

[1]Published with the approval of the Director of Research, N. C. State College, as paper No. 38 of the Journal Series.

of soap. The test was made on a bright clear day when a good breeze was blowing. Contrary to expectations only a very small percentage of the insects were killed. Many of the insects that were thoroughly covered with the spray never stopped moving and others quickly recovered from any ill effects. The spray material used had been giving nearly 100% kill in the small cages in the laboratory.

The greatest difference in conditions in the two cases seemed to be that of evaporation. To test the effect of this factor insects were sprayed in cages and immediately afterward placed in the sunlight and wind on a window sill while other lots were placed in a moist chamber at nearly the same temperature. The difference in results was striking. When insects were confined in the moist chamber a higher percentage was killed than with twice or even four times the concentration of the same kind of soap on insects which were quickly dried in the sunlight and wind.

Harlequin bugs that have survived a treatment of fairly strong soap solution by having it quickly evaporated, may be killed later by a quick dip or spray of water and subsequent confinement to a moist chamber. Unsprayed insects remained alive for several days in a moist chamber.

An attempt was then made to test the effect of a soap solution in air of known humidity by confining the sprayed harlequin bugs in jars over dry calcium chloride, sulphuric acid and concentrated salt solutions. This method was quickly abandoned because it soon became evident that extremely dry air in a confined space did not give as rapid a rate of evaporation as moving air of much greater humidity.

An apparatus was then set up to obtain atmometer records of evaporation for short periods of time. A potometer used by plant physiologists for measuring the rate of water loss from plants, was adapted to this purpose by fitting an atmometer bulb into the place usually occupied by a plant. Water is drawn through a horizontal tube graduated to hundredths of a milliliter. When readings are made air is admitted in place of water and its progress through the tube is timed. The atmometer bulb was enclosed in a wire cage similar to those used for confining the insects. Evaporation rate was varied artificially by means of a large electric fan. Insects to be tested were confined in a cage and dipped for five seconds in the solution. The excess material was quickly blown away by mouth and the cage suspended near the atmometer bulb.

The following table gives the results from a two per cent solution of soap used under various rates of evaporation. Chrystal Cocoa soap made by the Palmolive-Peet Company was used, since it had proved to be one of the most effective and does not form a gel in a cold two per cent solution. The evaporation rate given is the average for the period under

observation in milliliters per minute for a standard atmometer bulb. Ten insects were used in each trial and the final effect, an hour or more after treatment, is given. It was found that with healthy insects no further effect would take place after the soap solution had dried and that a few would sometimes revive on longer standing.

Evaporation in cc. per minute	Temperature °F	Relative Humidity	Final Effect on Insects: Number Crawling	Able to Move Legs	Number Dead
.0033	80	72	-	-	10
.0057	72	60	-	-	10
.0065	81	64	-	-	10
.0078	90	—	-	-	10
.0090	80	63	1	-	9
.0090	87	57	3	-	7
.0098	87	57	1	-	9
.0123	82	63	4	-	6
.0131	77	87	3	2	5
.0148	80	72	1	2	7
.0164	80	72	-	-	10
.0164	80	72	1	-	9
.0184	80	63	5	2	3
.0205	86	—	3	1	6
.0205	72	60	4	-	6
.0230	87	57	3	-	7
.0246	80	63	6	2	2
.0361	82	63	6	2	2
.0385	86	—	7	-	3
.0410	81	64	10	-	—
.0574	91	—	9	1	—
.0722	87	57	8	2	—

By averaging the results for those tests under approximately the same evaporation rates we get what is probably a more accurate picture of relation between killing effect and evaporation.

Evaporation per Min.	Per cent Killed
.0 to .01 cc.	91.9
.01 to .02 cc.	66.6
.02 to .03 cc.	52.5
.03 to .04 cc.	25.
more than .04 cc.	0

The same brand of soap was tested on adult Colorado potato beetles in a two per cent solution and on a species of aphid from Lactuca in a one-half per cent solution to see whether it affected other insects in the same way. These tests were made only under very high and very low evaporation rates. The results are given in the following tables:

Colorado Potato Beetle, Adults

Evap. Rate in cc per min.	Temperature F.	After 45 Minutes: Crawling	Move Legs	Dead
.0071	90	2	3	5
.0615	90	8	1	1

Aphid from Lactuca

Evap. Rate	Temperature F.	Per cent Killed
.0131	86	97.2
.0640	86	68.8

Other brands of soap tested in the same way gave similar results, showing that this relationship of killing effect to evaporation is not peculiar to any one kind of soap.

A number of tests were then made to see if the evaporation of the soap film could be retarded by the addition of from two to five per cent of hygroscopic substances such as glycerine, diethylene glycol and triethanolamine. Tests were made under both high and low evaporation rates with plain soap solution as a control. The differences in results did not seem to be greater than experimental error.

Additional field tests on harlequin bug after the discovery of the evaporation relationship, showed that with suitable weather conditions a high percentage of insects hit by the spray were killed. Adults are much more resistant than nymphs, which could be killed with less than a two per cent solution. On extremely humid days with no wind the control is limited only by the ability to hit the insects with the spray. This is not difficult on young cabbages, or collards or on seeding rutabaga tops which furnish a good trap crop in the spring. On large close headed collards or cabbages it is difficult to hit more than 50 to 75 per cent of the insects.

The author at first concluded from these experiments that under conditions of low evaporation the soap solution formed a surface film over the spiracles and cut off the air supply for a sufficient length of time to kill the harlequin bugs. To test this theory adults were confined in small cages and submersed in water that had been previously boiled to exclude air bubbles. They became apparently dead in about the same time as bugs treated with soap at the same temperature. But the insects that had been under water twenty-five minutes, the longest time that any were submersed, all revived and were apparently uninjured by the treatment. It was evident that the soap solution must have some effect other than the mere exclusion of the air during the period that it remains liquid.

A study of the anatomy of the spiracles of the adult harlequin bug showed they are all equipped with closing devices. The thorax has two pairs of spiracles. The first lie in the conjunctiva between the pro- and mesosternum and have access to the air only through the close fitting movable contact between those segments. The second lie in cavities between the meso- and metasternum and have access to the air through narrow rigid slits. The spiracles also have slit-like openings and the anterior lips are movable like a trap door and governed by muscles within the body. If portions of the pro- and mesosternum are cut

away from the living insect the flaps can be observed to open and close at intervals of a few seconds.

The abdominal spiracles have small circular openings. Attached to one side of the expanded tracheal trunk just inside the body wall is a cone-shaped chitinous process. One side of the base of the cone is hinged to the edge of the spiracle ring. A muscle runs from the apex of the cone to the body wall on the opposite side of the spiracle so that when contracted the cone is raised to a position nearly perpendicular with the body wall and its base completely covers the spiracle opening. The various types of spiracles of the Hemiptera have been described and figured by H. Mammen.[2] In the nymphs of the harlequin bug all of the closing devices appear to be in a rudimentary condition and are probably not functional.

By gluing a harlequin bug ventral side up on a card the action of the spiracles could be watched under a binocular. When soap solution is applied to the abdominal spiracles with a brush they close almost immediately and remain so until the solution dries. No liquid seemed to enter them and no air came out. When the solution was applied to thoracic spiracles which had been rendered visible by cutting away portions of the fold in the body wall, it was noticed that the flaps continued their opening and closing movements for a while and then remained closed. Some of the liquid entered these spiracles before they remained closed. India ink was mixed with soap solution and a drop of the mixture kept over a single thoracic spiracle for several minutes. The insects so treated did not seem to be seriously injured and after they had remained alive a few hours were cut open and presence of the ink could be detected in some of the main tracheal branches leading from the treated spiracle. This was true both of the first and second pairs of spiracles.

Adult harlequin bugs were dipped in soap solution to which India ink had been added, and later cut open to see how far the solution had penetrated into the tracheae. Most of those that died quickly showed ink in the thoracic tracheae and sometimes in the first abdominal tracheae but the remaining abdominal trachaea did not contain any ink. In many cases the ink had penetrated deeply and had blackened most of the smaller branches. Bugs that lingered longer before dying showed less extensive penetration of the solution and in some cases not all of the thoracic spiracles had been entered. Bugs that showed some effect from the treatment but continued to live and were apparently on the road to

[2]H. Mammen. Über die Morphologie der Heteropteren—und Homopterenstigmen. Zoologischen Jahrbüchern, Vol. 34 (No. 1) pp. 121–178, pl. 7–9, 1912.

recovery sometimes showed ink in some of the main thoracic tracheal trunks but in most of such cases no ink could be discovered at all. Immature harlequin bugs that were dipped in the mixture of soap solution and ink, showed penetration of the liquid into both thoracic and abdominal spiracles. This took place in only a small fraction of the time required for the solution to enter the tracheae of the adults.

CONCLUSIONS. Soap solutions kill harlequin bugs by penetrating deeply into the tracheal system through part or all of the spiracles. A small amount of soap solution in one or two of the tracheal trunks probably does not cause death. On account of the spiracle closing devices on the adult harlequin bugs, soap solutions must remain on the body several minutes before a quantity sufficient to cause death enters the tracheae. A much shorter time is required to kill the nymphs on account of the rudimentary condition of the spiracle closing devices, but under conditions of very rapid evaporation many of them will not be killed.

From a practical standpoint it is evident that when dealing with soap solution one should not follow the usual practice of spraying during fair weather unless it is applied early in the morning when dew is on the plants. With soap solution much better results can be obtained by spraying during a light rain than on a clear dry day, especially if a wind is blowing. On calm, cloudy, humid days soap is a very effective insecticide in solutions of from one-half to two per cent, depending on the insect to be treated. Considering that soap is always on hand in the household there is no reason why it should not be more extensively used as an insecticide for home gardens.

PHYSICAL AND CHEMICAL PROPERTIES OF COMMERCIAL ARSENICAL INSECTICIDES

I. MANGANESE ARSENATE

By F. E. DEARBORN, *Insecticide Division, Bureau of Chemistry and Soils, Washington, D. C.*

ABSTRACT

The patented methods of making manganese arsenates for insecticidal use consist in treating a manganese compound, such as pyrolusite, with white arsenic (As_2O_3) in the presence of nitric acid as a catalyst. The manganous arsenate formed is partly converted to the trimanganoarsenate by treatment with manganese carbonate to lower the water soluble arsenic content. The brown color of the insecticide is produced by treating the mixed arsenates with lime, which decomposes some of the arsenates, with the formation of calcium arsenate and hydrated oxides of manganese. Burnt umber is also generally added to cheapen the product.

The chemical analysis of the commercial insecticide shows that the total arsenic content runs close to 40 per cent calculated as arsenic pentoxide As_2O_5; that the

water soluble arsenic content ranges from 0.7 arsenic pentoxide As_2O_5; and that the total manganese calculated as to 1.5 per cent calculated as manganous oxide (MnO) ranges from 31.6 to 40.7 per cent. The lime content, present mostly as calcium arsenate, ranges from 15.5 to 16.4 per cent calculated as calcium oxide (CaO).

The commercial manganese arsenate insecticide is a complex mixture of various arsenates of manganese, calcium arsenate, oxides of manganese and smaller quantities of aluminum, iron, silica, etc. The composition of different samples is not the same.

Manganese arsenates have only recently been used as insecticides, although they have been known for a long time. No record was found in the literature on the chemical analysis of manganese arsenate insecticides. The purpose of this paper, therefore, is to outline the methods of preparation and to give data on the chemical composition of commercial manganese arsenate insecticides now on the market.

HISTORICAL. The manufacture of manganese arsenate as an insecticide grew out of a demand for a product which would not produce undesirable coloration of the tobacco plant. When lead arsenate or any other white insecticide is used on the tobacco plant, it produces on the dried and cured leaves an appearance of mold, which reduces the selling price of the tobacco.

Prior to the development of manganese arsenate, efforts were made to color insecticides, such as lead arsenate. It was found, however, that organic dyes were not sufficiently permanent and that the use of colored pigments was not satisfactory because a comparatively large quantity of pigment is required to be mixed with the material, and the arsenic content of the product was rendered too low for effective use.

METHODS OF MANUFACTURE. The commercial methods for preparing manganese arsenates for insecticides are covered by patents[1,2], and consist mainly in treating compounds of manganese, such as the carbonate ($MnCO_3$) or pyrolusite (MnO_2) with commercial white arsenic (As_2O_3) or arsenic acid (H_3AsO_4) in combining proportion, in sufficient water to form a slurry which can be easily agitated. The mixture is kept nearly at 100° C. with continuous agitation for about 24 hours. By using a catalyst, such as nitric acid, the reaction time is reduced. The reaction that takes place is:

[1]U. S. Patent, 1,580,200, issued to Henry Howard, Apr. 13, 1926; appl. May 15, 1922.

[2]U. S. Patent 1,574,118, Feb. 23, 1926; appl. Sept. 29, 1924.
U. S. Patent 1,648,596, Nov. 8, 1927; appl. Sept. 29, 1924.
Canadian Patent 266,536, July 6, 1926;
This group of patents was issued to William K. Schweitzer.
U. S. Patent 1,591,795 issued to W. L. Tanner July 6, 1926; appl. July 30, 1923.
U. S. Patent 1,648,577, issued to Harry P. Corson, Nov. 8, 1927; appl. Sept. 29, '24.

$$(1)\ 2MnO_2+As_2O_3+H_2O=2MnHAsO_4$$

The next step in the process is to reduce the water soluble arsenic present in the dimanganoarsenate ($MnHAsO_4$) by treating it with a small amount (5 to 10 per cent by weight of the white arsenic (As_2O_3) and pyrolosite (MnO_2) used) of a neutral or only slightly alkaline carbonate of a metal capable of forming an insoluble arsenate, such as manganese carbonate, calcium carbonate or magnesium carbonate. The carbonate is added to the reaction product obtained in (1) and the mixture agitated with heating to nearly 100° C. for 24 hours. The reaction that takes place when manganese carbonate is used, is:

$$(2)\ 2MnHAsO_4+MnCO_3=Mn_3\ (AsO_4)_2+CO_2+H_2O$$

The carbonate reacts with a portion of the $MnHAsO_4$, forming the trimanganoarsenate, and the water soluble arsenic content is reduced, the extent depending upon the quantity of carbonate used and the time allowed for the reaction.

The color of both the dimanganoarsenate and the trimanganoarsenate ranges from white to pink. In order to impart a brown color to the insecticide, an alkali, such as lime, is added to the reaction product obtained in (2) above. The quantity of lime added and the length of treatment controls the color imparted to the finished product. When the mixture is kept at nearly the boiling point and thoroughly agitated, a maximum effect is obtained with any given amount of lime in about 24 hours. Lime amounting to 10 per cent of the original dry charge of white arsenic (As_2O_3) and pyrolosite (MnO_2) imparts a dark brown color to the finished insecticide. The lime decomposes some of the manganese arsenates, forming the corresponding calcium arsenate and manganese hydroxide, which is converted by oxidation with or without accompanying hydration to brown colored hydroxides or hydrated oxides. The final reaction product is filtered, washed, dried and ground to a fine powder. The arsenic content is generally reduced by the addition of burnt umber, which also helps to impart a brown color to the finished insecticide.

Analyses of Manganese Arsenate Insecticides. Two samples of commercial manganese arsenate insecticides were analyzed to determine their composition. Sample No. 1 was labeled "Manganar" and had the following statement on the label:

	Per cent
Total arsenic oxide	40.00
Arsenic as metallic arsenic	26.00
Water soluble arsenic as metallic arsenic not over	.50
Manganese arsenate	68.00
Inert ingredients	32.00

Sample No. 2 was received from the Bureau of Entomology and was labeled "Manganese Arsenate". The methods of analysis used in analyzing the samples were taken from the A. O. A. C. manual (Second edition, revised to July 1, 1924) and "Standard Methods of Chemical Analysis," by Scott (Second edition, revised Jan. 1917).

The cubic inches per pound was determined by passing the insecticide through a 30-mesh sieve, held about an inch above the receiving vessel of known value. The material was carefully leveled off and then weighed. When the weight of the material held by a definite volume is known the cubic inches occupied by a pound of the insecticide is readily calculated.

The p-H value was determined by means of the LaMotte Comparator using the La Motte color Standards. Ten grams of the arsenate were mixed with 500 cc of distilled water at room temperature (approximately 25°C) and allowed to stand for two hours with frequent shaking. Then samples were filtered off, and the p-H value determined. The p-H of the distilled water used was 6.6.

The suspensibility tests to determine the rate of settling of the suspended insecticide in water were carried out at approximately 25° C. A 1.2 g. sample of the insecticide was shaken with 500 cc of distilled water contained in a 500 cc graduated cylinder, and after the cylinder had stood for a definite time, the top half (250 cc) was siphoned off into a weighed beaker. The beaker was placed on the steam bath and the contents evaporated to dryness. The beaker and residue were dried and then weighed. The weight of the salts obtained by evaporation multiplied by 100 and divided by 0.6 gives the per cent of material held in suspension.

The chemical and physical data obtained from analysis are tabulated in Table 1.

There is no definite way of calculating the composition of the insecticide from the analysis as we are dealing with mixtures of several compounds and substances of unknown composition used as fillers, such as burnt umber, containing aluminum, calcium, iron, manganese, magnesium, silica, and other matter. The theoretical composition of the dimanganoarsenate ($MnHAsO_4$) is: Manganese, calculated as the manganous oxide (MnO), 36.5 per cent; arsenic, calculated as arsenic pentoxide (As_2O_5), 59.0 per cent. The composition of the trimanganoarsenate is: Manganese calculated as the Manganous oxide (MnO), 48.2 per cent; arsenic, calculated as arsenic pentoxide (As_2O_5), 51.9 per cent.

The insecticides probably consist of the arsenates of manganese, a small percentage of calcium arsenate, oxides of manganese, together

TABLE 1. ANALYSIS OF COMMERCIAL MANGANESE ARSENATE INSECTICIDES

		Sample No. 1 Per cent	Sample No. 2 Per cent
Moisture		1.7	1.2
Total arsenic pentoxide (As_2O_5)		39.9	40.6
Total arsenious oxide (As_2O_3)		None	None
Water-soluble arsenic pentoxide (As_2O_5)		1.5	0.7
Total water soluble salts at 25° C.		4.4	7.0
Insoluble in hydrochloric acid (silicon dioxide, SiO_2)		0.8	1.4
Insoluble in nitric acid 1:1 (Oxides of Manganese)		5.5	7.3
Aluminum oxide (Al_2O_3); ferric oxide, (Fe_2O_3)		0.6	0.7
Total manganese as manganous oxide MnO		40.7	31.6
Total calcium oxide (CaO)		15.5	16.4
Total magnesium Oxide (MgO)		0.4	0.2
Cubic inches per pound		89.0	78.0
pH value of 2% solution		11.9	8.1
Suspensibility at 25° C.	2 minutes	61.0	75.0
	5 "	32.0	51.0
	10 "	20.0	27.0
	30 "	9.0	17.0
	60 "	8.0	14.0

with uncombined material, and fillers, such as burnt umber. It is quite probable that sample No. 1 contains more of the trimanganoarsenate than sample No. 2 as the manganese content is considerably higher with approximately the same arsenic and calcium content. Sample No. 1 was slightly darker in color than sample No. 2.

The material insoluble in nitric acid (1:1) gives a rough estimation of the oxides of manganese present in the insecticide.

Samples of the insecticides were submitted to mocroscopical examination[3] to determine their uniformity and other characteristics. The microscopical test showed that this product was not uniformly one substance, but consisted of a mixture of rods and brown, amorphous material. The indices of refraction were not measurable with the facilities available, as they were greater than n=1.69.

APPLICATION AGAINST INSECTS. A search of the literature revealed only a few references to experiments conducted with manganese arsenate against insect pests. The manufacturer places on the label of the container, together with the analysis, a statement that the product can by used for dusting tobacco, potato plants, cotton or truck crops.

D. E. Fink[4] made a study of the effect of the various arsenical compounds, including manganese arsenate, on the respiratory metabolism of the adult potato beetle, the larvae of the garden wire worm, and the

[3]The microscopical examination was carried out by George L. Keenan, of the Food, Drug and Insecticide Administration, Washington, D. C.

[4]Physiological Studies of the Effect of Arsenicals on the Respiratory Metabolism of Insects, J. Agr. Res. Vol. 33, No. 2, pp. 993–1007 (1926).

third stage larvae of the Japanese beetle. The evidence obtained points to the fact that arsenicals exert an inhibiting effect on the respiratory metabolism of the insects.

O. I. Snapp[5] made toxicity tests with a number of compounds against the plum curculio by spraying and dusting peach trees. Manganese arsenate was found to be less effective than the arsenates of lead, barium, calcium, zinc or magnesium.

The report[6] of the Committee to Formulate Plans for Investigating the Codling Moth states that three laboratory and seven field tests shows that manganese arsenate is about two-thirds as effective as lead arsenate. One case of severe injury and several cases of moderate injury to the trees were recorded.

D. J. Caffrey and L. L. Huber[7] experimented with manganese arsenate against the European corn borer and found it gave no effective protection for the growing corn.

C. H. Alden and M. S. Yeomans[8] carried out field experiments consisting of spraying and dusting apple orchards against the codling moth.

H. C. Young[9] used sulphur dust combinations against the apple scab. Sulphur-Manganar (Manganese arsenate) mixtures gave good control but caused slight injury.

R. L. Miller[10] states that manganese arsenate when used in the laboratory alone or with lime was not quite so effective in preventing the entrance of the newly hatched codling moth larvae into carefully sprayed apples as was lead arsenate. When mixed with lime-sulphur there was little difference in the effectiveness of the two materials. In the field tests manganese arsenate gave as good or better results when mixed with lime-sulphur as did lead arsenate. Lead arsenate was slightly better than manganese arsenate used alone. The residue of manganese arsenate was more easily removed from the apples than was that of lead arsenate.

[5]A Preliminary Report of Toxic Value of Fluosilicates and Arsenicals as tested on Plum Curculio, J. Econ. Ent. *21*, No. 1, pp. 175–178 (1928).

[6]Report of Committee to Formulate Plans for Investigations of the Codling Moth from Biologic and Control Standpoints. J. Econ. Ent. *21*, No. 1, pp. 36 (1928).

[7]Fundamental Phases of European Corn Borer Research. J. Econ. Ent. *21*. No. 1, pp. 104 (1928).

[8]Codling Moth Control in Georgia Apple Orchards. J. Econ. Ent. 21, No. 2, pp. 319 (1928).

[9]Ohio Agricultural Experiment Station Bimonthly Bulletin *14* No. 2, Mar. Apr. 1929.

[10]Manganese Arsenate as a Control for the Codling Moth, J. Econ. Ent. *22*, No. 2, pp. 340 (1929).

PRELIMINARY REPORT ON PARADICHLOROBENZENE SOLUTIONS FOR THE CONTROL OF THE LESSER PEACH BORER, *AEGERIA PICTIPES*, G. & R.

By OLIVER I. SNAPP, *Entomologist*, and H. S. SWINGLE, *Assistant Entomologist*, *Division of Deciduous Fruit Insect Investigations, U. S. Bureau of Entomology*

ABSTRACT

Paradichlorobenzene solutions appear very promising for the control of the larvae of the lesser peach borer in peach trees. The best of these solutions tried was that in which crude cottonseed oil was used as the solvent for the paradichlorobenzene.

The lesser peach borer has been recognized as a pest of considerable importance upon peach since 1896. While apparently preferring peach, it also attacks and causes more or less injury (2)[1] to plum, cherry, June-berry, beach plum, and chestnut.

Injury is due to the destruction of the cambium and inner bark layers by the feeding of the larvae. In severe cases limbs may be entirely girdled and killed, and in practically all cases the trees are very greatly weakened As these larvae apparently prefer to enter only thru wounds in the outer bark, or at old crotches or sun scalded areas, severe injury is largely confined to older trees.

The only control previously recommended as effective was hand worming. Owing to the unsatisfactory nature of this method of control, and to the fact that trees are very seldom killed by the attacks of this insect, no control measures whatever have been used in Georgia peach orchards, with a few exceptions. As a result heavy infestations can usually be found, especially in the older orchards.

The success of Hamilton (3) with a solution of paradichlorobenzene in soluble pine-tar creosote for the control of various boring insects, and of Gilbertson (1, 4, 5) with a solution of this same insecticide in melted paraffin for the control of the lesser peach borer in plum trees, stimulated interest in this method of control for the latter insect in peach trees. The work here reported was carried on at the U. S. Peach Insect Laboratory, Fort Valley, Georgia, during 1928 and 1929. While of a preliminary nature, the results seemed of sufficient importance to be reported at this time.

EXPERIMENTAL. A paraffin solution of paradichlorobenzene, as recommended by Gilbertson (4), was applied to the infested portion of peach trees on November 7, 1928. This contained one pound paradichlorobenzene dissolved in four pounds of paraffin. As it was felt that

[1]Numbers in parenthesis refer to "Literature Cited."

the paraffin might prove too brittle, grafting wax was substituted for the paraffin in another series of tests. These solutions were kept warm and were applied to the infested portions of the trees with a paint brush, no attempt being made to remove the gum or frass or to otherwise expose the tunnels of the larvae. The results of these tests are given in Table 1.

TABLE 1. RESULTS OF TESTS WITH PARADICHLOROBENZENE SOLUTIONS APPLIED NOV. 7, 1928, FOR THE CONTROL OF THE LESSER PEACH BORER

Material used	Total Larvae examined and the per cent found dead at each examination after exposure of— 1 week		2 weeks		3 weeks		6 weeks	
	Total	Per cent dead	Total	Per cent dead	Total	Per cent dead	Total	Per cent dead
Paraffin and paradichlorobenzene	22	54.5	46	65.2	33	40.0	14	85.7
Paraffin alone	11	9.1	25	0.0	15	0.0	21	0.0
Grafting wax and paradichlorobenzene	18	44.4	24	29.2	13	38.5	—	—
Grafting wax alone	13	0.0	20	0.0	10	10.0	—	—

Altho these results appeared promising, it was evident that this method of control would not prove very popular unless some material, not requiring the use of heat to render it fluid, were substituted for the above solvents. Therefore, solutions of paradichlorobenzene dissolved in soluble pine-tar creosote and in cottonseed oil were tried in comparison with the paraffin solution. One pound of paradichlorobenzene was dissolved in one quart of soluble pine-tar creosote, and then diluted with one quart of water as recommended by Hamilton (3); and one pound was also dissolved in two quarts of crude cottonseed oil. These materials were applied with a brush on April 2, 1929, and the results of these tests are given in Table 2.

TABLE 2. RESULTS OF TESTS WITH PARADICHLOROBENZENE SOLUTIONS APPLIED APRIL 2, 1929, FOR THE CONTROL OF THE LESSER PEACH BORER

Material Used	Total Larvae examined and the per cent found dead at each examination after exposure of 1 week		2 weeks	
	Total	Per cent dead	Total	Per cent dead
Paraffin and parachlorobenzene	9	77.7	33	90.0
Cottonseed oil and paradichlorobenzene	10	90.0	47	97.9
Cottonseed oil alone	—	—	11	45.4
Soluble pine-tar creosote and paradichlorobenzene	11	72.7	14	85.7
Soluble pine-tar creosote alone	9	11.1	20	20.0
Check—untreated	—	—	15	6.6

DISCUSSION OF RESULTS. The spring applications (Table 2) gave uniformly better results owing to the more rapid volatilization of the para-

dichlorobenzene, caused by the higher temperatures prevailing during the two-week period of these tests. The average temperature thruout this period was 69.1°F. and the maximum for every day was above 70°F. The average temperature for the corresponding period of the fall tests (Table 1) was 57.5°F. and the maximum daily temperatures reached 70°F. or above on only seven of the first fourteen days during that period. Apparently fall applications must be made earlier than November for most effective results.

Grafting wax proved no more effective than paraffin as a solvent and was much more disagreeable to use. The paradichlorobenzene dissolved in paraffin proved effective, but did not give quite as good control as when crude cottonseed oil was used as the solvent. This was probably due to the better spreading and penetrating power of the latter.

Soluble pine-tar creosote as a solvent gave as good results as the paraffin.

It seems quite probable that a solution of paradichlorobenzene in any solvent having good penetrative power would prove effective.

Cottonseed oil and the creosote both showed some insecticidal action when used alone, apparently acting as contact insecticides.

The somewhat erratic results noted in Table 1 were apparently due to the excessive quantities of gum produced by some trees closing the larval burrows and preventing the penetration of the insecticide. Better results would be secured if this were removed before the application.

No injury to the trees could be detected.

Literature Cited

1. Gilbertson, G. I. 1929. Controlling Plum Pest with P.D.B. Am. Fruit Growers Magazine, May, 1929, page 10.
2. Girault, A. A. 1907. The Lesser Peach Borer. U. S. Bureau of Entomology Bul. 68, Part 4.
3. Hamilton, C. C. 1926. Some Tests of Para-dichlorobenzene Dissolved in Soluble Pine Tar Creosote in the Control of Boring Insects in Living Plants. Report Dept. Entomol. N. J. Agr. Exp. Sta. for Year Ending June 30, 1926, pages 196–197.
4. South Dakota Agricultural Experiment Station. 1927. The Plum Tree Borer. Annual Report of the Director for the Year Ending June 30, 1927, pages 15–18.
5. ——— 1928. The Plum Tree Borer. Annual Report of the Director for the Year Ending June 30, 1928, pages 17–18.

COMMON NAMES OF INSECTS APPROVED FOR GENERAL USE BY AMERICAN ECONOMIC ENTOMOLOGISTS

Fifth Supplement to List Appearing in Volume 18, Pages 521–545, 1925

A list of 36 common names was submitted to the active members of the Association for approval with the understanding that a name be considered adopted when less than 20 per cent of the votes cast was in opposition. Of this list the following 23 names received the necessary votes for adoption:

Insects Listed by Scientific Names

Anthonomus grandis thurberiae Pierce	Thurberia weevil
Anticarsia gemmatilis Hbn	Velvetbean caterpillar
Argyresthia conjugella Zell	Apple fruit moth
Barathra configurata Walk	Bertha armyworm
Chalcodermus aeneus Boh	Cowpea curculio
Cryptococcus fagi Bar	Beech scale
Ellopia fiscellaria Guen	Hemlock spanworm
Eriophyes gossypii Banks	Cotton blister mite
Hemerophila pariana Clerck	Apple and thorn skeletonizer
Hypoderma bovis DeG	Northern cattle grub
Hypoderma lineatum DeVill	Common cattle grub
Laspeyresia molesta Busck	Oriental fruit moth
Myelois venipars Dyar	Navel orange worm
Nephopteryx rubrizonella Rag	Pear fruit borer
Parlatoria blanchardi Targ	Parlatoria date scale
Pegomyia hyoscyami Panz	Spinach leaf miner
Phoenicococcus marlatti Ckll	Red date scale
Phytonomus nigrirostris Fab	Lesser clover leaf weevil
Pogonomyrmex barbatus Mayr	Red harvester ant
Pseudococcus maritimus Ehrh	Grape mealybug
Pulvinaria amygdali Ckll	Cottony peach scale
Rhagoletis juglandis Cress	Walnut husk fly
Rhizoglyphus hyacinthi Boisd	Bulb mite

Insects Listed by Common Names

Apple and thorn skeletonizer	Hemerophila pariana Clerck
Apple fruit moth	Argyresthia conjugella Zell.
Beech scale	Cryptococcus fagi Bar.
Bertha armyworm	Barathra configurata Walk.
Bulb mite	Rhizoglyphus hyacinthi Boisd.
Common cattle grub	Hypoderma lineatum DeVile.
Cotton blister mite	Eriophyes gossypii Banks
Cottony peach scale	Pulvinaria amygdali Ckll.
Cowpea curculio	Chalcodermus aeneus Boh.
Grape mealybug	Pseudococcus maritimus Ehrh.
Hemlock spanworm	Ellopia fiscellaria Guen.
Lesser clover leaf weevil	Phytonomus nigrirostris Fab.
Navel orange worm	Myelois venipars Dyar
Northern cattle grub	Hypoderma bovis DeG.
Oriental fruit moth	Laspeyresia molesta Busck
Parlatoria date scale	Parlatoria blanchardi Targ.
Pear fruit borer	Nephopteryx rubrizonella Rag.
Red date scale	Phoenicococcus marlatti Ckll.
Red harvester ant	Pogonomyrmex barbatus Mayr
Spinach leaf miner	Pegomyia hyoscyami Panz.
Thurberia weevil	Anthonomus grandis thurberiae Pierce
Velvetbean caterpillar	Anticarsia gemmatilis Hbn.
Walnut husk fly	Rhagoletis juglandis Cress.

IMPORTANT NOTICE

43rd Annual Meeting of the American Association of Economic Entomology, Cleveland, Ohio, December 29, 1930 to January 2, 1931

As a result of correspondence with the Sections of this Association, the Committee on Program and the Entomological Society of America, a schedule has been arranged for the sessions at the Cleveland meeting. This information is made available at this time for the information of the members and in the hope that it will stimulate attendance at the meeting.

Monday, December 29, 1930—The section of Apiculture will hold sessions in the morning and afternoon.

Tuesday, December 30, 1930—The section of Plant Quarantine and Inspection will hold sessions in the morning and afternoon. The Entomological Society of America will hold sessions in the morning and afternoon and the public address before that Society will be held in the evening.

Wednesday, December 31, 1930—The general session of this Association will be held in the morning and afternoon and the Entomological Society of America will also hold sessions during those periods. The Entomologists dinner will be held in the evening.

Thursday, January 1, 1931—General sessions of the Association will be held in the morning and afternoon and the Extension Entomologists will meet in the evening.

Friday, January 2, 1931—General sessions of the Association will be held in the morning and afternoon, the final business being conducted at the closing session.

A. F. Burgess, *Secretary*

Scientific Notes

A New Host Record for the White Pine Weevil. To the list of native and exotic conifers known to be attacked by the white pine weevil, *Pissodes strobi* (Peck), *Pinus montana*, the ornamental Swiss mountain pine, may be added. A variety of this pine, *Pinus montana mughus*, has already been reported in the literature as a host plant (MacAloney).

The Mount Desert Nurseries, Bar Harbor, Me., brought to the attention of the writer the infestation of a number of their mountain pines. The leaders, which presented the usual weeviled appearance, when dissected, offered definite evidence that *Pissodes strobi* was the insect responsible for the injury.

In the material examined, the fly, *Lonchaea corticis* Taylor, which is facultatively parasitic upon this weevil, was noted (a new record for the island).

Raymond L. Taylor, *Maine Forest Service Entomological Laboratory, Bar Harbor*

An Unrecorded Food-Habit of the Large Tobacco Suck-Fly in Porto Rico. The large tobacco suck-fly, *Dicyphus luridus* Gib., has been known for some time as a relatively unimportant pest of tobacco in Porto Rico. Its injury has always been described, however, as damage to the leaves from which it sucks the juices, thus tending somewhat to weaken the plant.

Early in March 1930 Mr. J. A. B. Nolla of the Division of Botany of the Insular Experiment Station reported serious injury to the flower-buds of tobacco in a large breeding experiment which he was conducting near Caguas, P. R. Injury to the

flower-buds of tobacco would, of course, tend to reduce seed production but in this case it was particularly desirable to keep these parts intact for the purpose of obtaining as much seed as possible from presumably desirable new strains.

On March 14 the writer accompanied Mr. Nolla to Caguas to observe the damage. The insects were found to be exceedingly abundant on the plants selected for breeding purposes and which were situated in the center of a large field of tobacco. Many of the flower-heads almost literally swarmed with suck-flies and when disturbed the adults flew out in considerable numbers. The extraction of the juices was causing the flower-buds to fall, thus reducing the number of potential seed-capsules in most of the plants to not more than 10 per cent. After removing all opened flowers a paper bag had been fastened with a paper-clip over each flower-head to prevent cross-pollination. These bags had, however, failed to keep out sufficient of the suck flies to prevent considerable loss.

M. D. LEONARD, *Chief Div. of Entomology Insular Experiment Station at Rio Piedras, P. R.*

Further Notes on the Hawthorn Carposina Which Attacks Apples in Missouri. At the Des Moines meetings[1] the writer gave a short paper on the new mining caterpillar of apple which was identified as a species of Carposina. Breeding material kept in the laboratory during the winter is just beginning to emerge and specimens of the moths have been sent to the Bureau of Entomology for identification. The material kept under outdoor conditions is still in the larval stage and it is believed that the moths will not emerge until fall when apples and red haws are attacked by the larvae.

Before pupating the larva opens its spherical cocoon, drags it to the surface of the ground, and enlarges it so that it is about ten millimeters long, or twice its original diameter. Then it pupates being at first whitish but, when the moth is ready to emerge, it takes on a darker color. The pupa is about 6 to 8 millimeters long. The adult is a beautiful gray moth with small dark patches of elevated scales on the front wing. It has recently been identified by Mr. Heinrich, as *Carposina fernaldana.*

LEONARD HASEMAN, *University of Missouri*

Terpineol, a Solvent for Removing a Commercial Tree-Banding Material from Insects. In its study of the dispersion of certain insect pests, the Division of Cotton Insects of the U. S. Bureau of Entomology is using screens coated with a commercial tree-banding material to capture insects in flight. Many of these insects that were received by the Taxonomic Unit of the U. S. Bureau of Entomology were so heavily coated with this adhesive that they could not be studied. At the request of Dr. Harold Morrison, the writer endeavored to dissolve the adhesive from the insects. Of numerous solvents tested, only one, terpineol, was entirely satisfactory.

Entomologists wishing to use this adhesive for collecting insects may remove it from their specimens as follows: Coated insects are immersed in terpineol and heated on a boiling water bath for about five minutes, or longer, if necessary. The cleaned insects can then be transferred directly to alcohol or can be pinned. Coated specimens that have been preserved in alcohol can be treated equally well with terpineol. Insects as delicate as aphids can be cleaned without injury by the foregoing methods.

F. L. CAMPBELL, *U. S. Bureau of Entomology*

[1]Journal of Economic Entomology, Vol. XXIII, No. 1, Page 91.

***Dicyphus minimus* Uhler, a Pest on Tomatoes (Hemiptera, Miridae).**[1] During the past summer, 1929, complaints of an unusual type of insect attack upon tomatoes were received by this department. These complaints came from several different localities in Texas and the damage reported as being severe. Upon receipt of specimens the pest was found to be *Dicyphus minimus* Uhler. Some time later this species was found attacking tomatoes on the horticultural farm at College Station, Texas. Observations of the damage being done here convinced the writer of the seriousness of this pest and also confirmed the reports from other localities.

The pest was first reported early in July and occurred in enormous numbers throughout the summer and fall, disappearing only with the coming of cold weather. The nymphs were found principally on the underside of the leaves while the adults were to be found on any part of the plant. Leaves, stems, blossoms, and small fruits were attacked, all showing characteristic lesions and scars that are produced by the feeding punctures made by members of this family. The leaves began to show numerous white spots and later to turn yellow and curl around the edges. The young fruits were punctured either before or at blooming time, which caused them to drop off. One report from San Marcos, Texas, stated that several acres of tomatoes produced only a very small percentage of a normal crop because of the damage done by this insect.

Dicyphus minimus Uhler was first reported by A. L. Quaintance (Fla. Agr. Exp. Sta. Bul. 48, 1898) as being the most serious pest on tobacco in Florida. In this bulletin is given the complete life history and control of the species with illustrations of the nymph and adult. He states that the pest has been observed during October, November and early December on tomato vines and egg plants, but were nothing like so numerous as on tobacco.

Dr. H. H. Knight (Can. Ent. LIX. 36, 1927) states that this species breeds on *Nicotiana trigonophylla* and the writer, during the summer 1929, collected specimens in Mississippi that were breeding on *Solanum nigrum*. It probably breeds also on other wild solanaceous plants.

H. G. Johnson

Relative Covering Power of a Miscible Oil and Lubricating Oil Emulsions. Since the publication of the first report on this subject in the Journal of Economic Entomology, Vol. 22, No. 5, October, 1929, an interested manufacturer has raised the question of the size of the aperture in the nozzle discs used in the tests. We have therefore repeated the tests, using nozzles and discs supplied by the manufacturer in question, and nozzles and discs of the kind that are generally used in the Georgia peach belt.

The commercial miscible oil used for the first tests was again selected for comparison with Government-formula soap lubricating-oil emulsion and a commercially manufactured soap lubricating-oil emulsion. The second tests included the number of trees covered by 200 gallons of each insecticide and the time required to spray out 200 gallons of each into barrels. The most uniform trees in this section were selected for the tests, and all sprays were applied with a power outfit maintaining a constant pressure of 225 pounds. Two of the best spray men in this locality did the spraying under the supervision of the writers.

[1]Contribution No. 21 from Department of Entomology, A. and M. College of Texas, College Station, Texas.

The results of these tests were as follows

Test No.	Insecticide used[1]	Nozzles used on each of two leads of hose	Number of trees covered by 200 gallons	Time required to spray 200 gallons on trees	Time required to spray 200 gallons into barrels
1	Commercial miscible oil	Cluster of 4 supplied by manufacturer			51 minutes
	Government-formula soap-oil emulsion	Cluster of 4 supplied by manufacturer			48 minutes
	Commercial soap-oil emulsion	Cluster of 4 supplied by manufacturer			50 minutes
2	Commercial miscible oil	Twin, purchased locally (small aperture in discs)	246	1 hr. 34 min.	
	Government-formula soap-oil emulsion	Twin, purchased locally (small aperture in discs)	290	1 hr. 32 min.	
	Commercial soap-oil emulsion	Twin, purchased locally (small aperture in discs)	244	1 hr. 38 min.	
3	Commercial miscible oil	Clusters of 4 supplied by manufacturer	192	1 hr. 4 min.	
	Government-formula soap-oil emulsion	Clusters of 4 supplied by manufacturer	178	1 hr. 0 min.	

OLIVER I. SNAPP and J. R. THOMSON,
U. S. Peach Insect Laboratory, Fort Valley, Georgia

Peruvian Potato Pests. The original habitat of the so-called Irish potato is not Ireland, as its name might appear to indicate, but the foothills and valleys of the Andean mountains in South America, much of which region is included in the non-tropical portions of Peru. Little is known of the insect pests attacking the potato in Peru, the most extensive article concerning them consisting of descriptions of beetles taken from tubers being imported into the United States and intercepted by agents of the Federal Horticultural Board. (Pierce, W. Dwight, "New Potato Weevils from Andean South America." Jour. Agr. Research, Vol. 1, No. 4, pp. 347–352, pl. 3, Jan. 10, 1914. Washington, D. C.) These beetles and their larvae are by no

[1]The diluted miscible-oil spray contained 5.5 per cent of oil by volume, whereas the oil emulsions contained 3 per cent of oil by volume. These are the strengths recommended in this locality.

means the most destructive pests of the tubers, which are more often attacked by pale greyish-yellow cut-worms of which the reared adults have recently been identified by Mr. Wm. Schaus as *Lycophotia interrupta* Maassen. These caterpillars feed on the tubers in the ground, hollowing out great cavities and entirely unfitting those attacked from being consumed by man. They are possibly more of a benefit than otherwise, however, in cleaning up all the small potatoes and culls left in the fields when the crop is dug, so that there are seldom any volunteer potato plants in a following crop. The extent of the distribution of this cutworm is unknown, the present record being from near Lima.

The foliage of the potato plants around Lima appeared to be almost entirely devoid of insects, the rather rare large green leafhoppers sometimes noted on it having been identified only to genus, *Cicadella* sp. In the mountains, however, at least two species of leaf-feeding beetles have been observed in enormous abundance on potato and causing very serious damage. The genus of the "old-fashioned potato beetle" is represented by *Epicauta latitarsis* Haag, as determined by Mr. G. E. Bryant of the British Museum, a rather small, blue-black species found in great abundance at Tarma in February 1929 by Dr. E. V. Abbott. Even more interesting was a small Dasytid beetle, dull chestnut brown and irridescent greenish blue-black in color, *Astylus sublunulatus* Pic, which was very abundant feeding on potato foliage in fields around Huancayo. Both of these beetles are well known to the native potato growers, who had both Spanish and Quechwa (Indian) names for them, but the idea of destroying them or doing anything to protect their crops from them is too radical and revolutionary to be considered.

GEORGE N. WOLCOTT, *Barneveld, N. Y.*

Injury to Celery in the Sanford, Florida, District by the Larvae of the Noctuid Moth *Perigia sutor* Guen. The unprecedented prevalence of the noctuid, *Perigea sutor* Guenee, in the larval stage on celery in the Sanford, Florida, district during the earlier part of the growing season 1929–30 has been marked by a certain amount of damage to the crop. Since the insect occurred in only a few localized areas in the district during the 1928–29 season it did not then attract the attention of the growers but its far greater abundance and wider distribution during the current season caused some apprehension among them.

Moths reared from larvae taken on celery in the field in December were determined as this species by Dr. Wm. Schaus of the taxonomic unit of the U. S. Bureau of Entomology.

Our field observations indicate that the larvae of *P. sutor* are most abundant in celery of medium or good size, in December and January; after this time they did not occur in sufficient numbers to attract attention. Apparently they are more or less nocturnal in their feeding habits, for during the day they are frequently found lying in the crown of the plant where little feeding injury is to be noted. Often they lie in the inner concave side of the base of a petiole where the most conspicuous damage is done. Here large irregular cavities or elongate grooves are cut, sometimes almost through the petiole. The tissue immediately adjacent to the feeding area becomes discolored, and not infrequently decay sets in and renders this part of the plant unfit for packing, so heavier stripping becomes necessary at the time of harvest.

By way of acquiring roughly some notion of the injurious habits of these larvae, 60 celery plants were selected at random in one of the most heavily infested fields

about Sanford in December, 1929. Of these plants, 17 were badly injured, 31 were slightly injured, and 12 showed no injury. It seems likely that most of the damage observed was done by the larvae of *Perigea*, since they comprised 63 per cent of all the larvae present in the field.

Again, in an attempt to formulate some opinion regarding the relative abundance and seasonal occurrence of these larvae, surveys taken in 1929 on a field of nearly mature celery showed the presence of injurious larvae in the following proportions:

	December Per cent	January Per cent
P. sutor	17	63
"Cutworms"	23	14
"Loopers"	11	14
Semitropical army worm (*Prodenia eridania* Cram.)	49	9

It seems, therefore, that while the larva of this noctuid has not before been recorded as being of economic importance in the production of celery, its apparent increase in abundance in the Sanford district in the past few seasons, together with the nature of the damage that it inflicts, causes it to be reckoned as a potential pest and worthy of consideration as such.

DAYTON STONER and C. B. WISECUP, *U. S. Bureau of Entomology*

Longevity of the Mexican Bean Beetle in the Southwest. On July 11, 1924, at Estancia, N. Mex. overwintered Mexican bean beetles were collected, marked and liberated for the purpose of obtaining records of dispersal. At that time the majority of the beetles were just issuing from hibernation and had not yet deposited eggs. One of the marked beetles was recaptured in the same field on September 12, 1924. This beetle had undoubtedly matured by September 1, 1923, since the last beans in the locality had been harvested by September 16, 1923.

On September 12, 1924, this beetle was transferred to a wide-mouthed bottle containing moist sand and placed in the laboratory. Moisture was supplied at intervals by adding water to the sand. The female was observed daily and found dead on January 18, 1925. This female beetle lived approximately 505 days.

Beetles were collected in the Rio Grande Valley near Albuquerque, New Mexico, on September 15 or 16, 1927, transported to the laboratory, and retained in a concentration cage and fed daily until October 6. On this date the insects were placed in a hibernation cage at 7,050 feet elevation. On May 10, 1928, a roof was placed over the cage to exclude natural precipitation during the emerging season. One of the beetles had not emerged from hibernation by August 4, when the last seasonal examination was made. On October 4, a female beetle (No. 2) was noted in the cage crawling over the hibernation material. It was removed from the cage and placed on beans in the insectary. On October 15, it was transferred from the insectary to the cellar for hibernation, and died sometime during the winter. This beetle lived a minimum of 396 days and was without food for 363 days.

On September 11, 1928, beetles were collected in the Rio Grande Valley. They were handled similarly to beetle No. 2 during the pre-hibernation period. On September 28 they were transferred to a hibernation cage at 8,400 feet elevation and during the summer of 1929 active beetles were removed at intervals until emergence had apparently ceased. The last examination was made on August 18. However, on September 24, 1929, a female beetle was noted crawling on the wire screen in the cage.

The beetle was removed from the cage and placed in the cellar to hibernate. It was observed daily and died on October 21, 1929. This female lived a minimum of 405 days and was without food for 392 days.

In 1924 the length of life of 23 overwintered beetles varied from a mimimum of 287 to a maximum of 410 days with an average of 357 days. One male and 2 females were placed in hibernation on October 15 but did not survive the second winter.

In 1925 the length of life of 33 overwintered beetles varied from the minimum of 261 days to the maximum of 418 days; with an average of 375.5 days. One of them, a male beetle, was placed in hibernation on November 4 and died during the second winter.

In 1926 the length of life of 46 overwintered beetles varied from a minimum of 267 days to a maximum of 413 days; with an average of 357 days. Two males and one female were placed in hibernation on October 25, but none survived the second winter.

In 1927 the length of life of 46 overwintered beetles varied from a minimum of 271 to a maximum of 388 days; with 361 days as the average. Eleven males and 6 females were placed in hibernation on October 12 for the second time but succumbed before spring.

In 1928 the length of life of 47 overwintered beetles varied from a minimum of 271 to a maximum of 440 days; with an average of 373 days. Of the 47 beetles twelve males and 5 females were placed in hibernation on October 16, but again all of them died during the second winter.

In 1929 the length of life of 44 overwintered beetles varied from a minimum of 301 to a maximum of 454 days, with an average of 371 days. Five males and 2 females were placed in hibernation on October 16 for their second winter. The last beetle lived 491 days and died on December 16.

J. R. DOUGLASS, *Associate Entomologist, U. S. Bureau of Entomology*

ROCKY MOUNTAIN CONFERENCE OF ENTOMOLOGISTS

The seventh annual meeting of the Rocky Mountain Conference of Entomologists will be held in Pingree Park, Colorado, August 18 to 23. Anyone interested in attending this meeting can get further details by writing the Secretary. The meeting is so arranged that members of the family can join in the gathering. Meals and bedding are furnished at the Colorado Agricultural College Forestry Lodge, at cost. The sessions for papers are usually quite informal with ample time for discussion. Time is provided for collecting and a certain amount of recreation.

GEORGE M. LIST, *Secretary.*

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

JUNE, 1930

The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication at $2.50 per page for all matter in excess of six printed pages, a part page counting as a full page, this limit not including acceptable illustrations. Photo-engravings may be obtained by authors at cost.

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ANNUAL SCIENTIFIC MEETINGS: 1930–31, Cleveland; 1931–32, probably New Orleans; 1932–33, Chicago; 1933–34, undecided; 1934–35, probably Rochester.

It is a source of gratification to note the recent deposit in the United States National Museum of a valuable collection of Philippine Island insects. Our National Museum should be the repository of all noteworthy collections. The further development of this policy may well be a matter of concern to economic entomologists, since in the final analysis, accurate records are impossible without authoritative determinations, and these can be made only by an adeouate corps of specialists with abundant material at hand from all parts of the world. The interests of economic entomology can not be limited by frontiers or even by oceans—they are world wide in scope.

An experiment covering tracts totaling 1000 acres is out of the ordinary. It has been made possible by a Congressional appropriation of $100,000 for work with the oriental fruit moth. The bill provided for large scale experiments with bait traps on two 500 acre tracts located in different fruit sections in order to obtain data as to the efficacy of the method. The localities selected are Cornelia, Ga., and Vincennes, Ind. A test over such an area should give information of great practical value and in connection with this, much other data will be obtained, some of which should be of value not only in controlling the oriental fruit moth but of service in checking other pests.

Reviews

The Use of the Microscope, A Handbook for Routine and Research Work by John Belling, pages I–XI, 1–315. McGraw-Hill Book Company, New York, 1930.

This is a well written, comprehensive account of the microscope and its possibilities, prepared by one qualified by years of experience in microscopic work. The volume is concerned primarily with descriptive accounts of various types of microscopes, the possibilities with the use of various accessories, methods of testing and drawing and is concluded with a comprehensive bibliography for those who wish to go beyond the limits of its pages. There are several excellent features in this work, namely, the practical points summarizing the contents of the more important chapters, the list of one hundred microscopical objects with brief technical directions for manipulation and the series of 200 questions which can be used by reader or student to test his understanding of the information presented in this volume. The book should be on the shelves of all engaged to any extent in microscopic work.

E. P. F.

A General Textbook of Entomology, Including the Anatomy, Physiology, Development and Classification of Insects by A. D. Imms, pages I–XII, 1–703, 607 figures. E. P. Dutton & Company, Inc., New York, 1929.

This revised edition of a really comprehensive reference textbook dealing with the anatomy, physiology, development and classification of insects is too well known in its first edition to require an extended review at this time. The volume is a well arranged, well balanced discussion of the phases of entomology ordinarily covered by several distinct and independent works. The revision, mostly as addenda and the insertion of supplementary references, brings the book up to date and leaves little to be desired by those wishing general information in relation to many phases of entomology.

The aim of the author has been to provide a textbook of collegiate and university grade for the use of both teacher and advanced student. He has succeeded admirably in the presentation of subject matter and the numerous well selected references for each of the important divisions make this volume an excellent introduction to the extensive and varied sources of original information. The discussions of anatomy and physiology are as indispensable to the entomologist or student resident in the tropics as to those working under the climatic conditions of the temperate zone. The marked attention given to the early stages is a most commendable feature. The world wide scope of the work makes it almost indispensable to those interested in the broader lines in any part of the world.

E. P. F.

Current News Notes

Geo. W. Still, Assistant Entomologist, Bureau of Entomology, was reinstated on April 2 for duty at Sandusky, Ohio.

T. E. Bronson, formerly Agent, Bureau of Entomology, at the Madison, Wis., field laboratory, has received a probational appointment as Junior Entomologist.

Mr. N. A. Patterson, Entomological Branch, who has been taking postgraduate studies at Macdonald College, Quebec, returned to the laboratory on Feb. 24.

Dr. M. W. Blackman, specialist on bark beetles, left Washington on May 1 for a summer's field work on forest insects at Prescott, Ariz.

On March 31, A. O. Larson, Bureau of Entomology, who had for some time been in Washington, preparing manuscripts, left for his office at Modesto, Calif.

In March, Emory D. Burgess was appointed Junior Entomologist for duty at Arlington, Mass., and Antonio A. Celaya, Junior Laborer, for duty at Tempe, Ariz.

Joseph R. Gross has been given a temporary appointment as Field Assistant, Bureau of Entomology, for duty at Babylon, N. Y., in connection with the investigations of bulb insects.

Miss Irene Bartlett, a graduate in entomology of the Massachusetts Agricultural College, has been appointed Junior Entomologist, to assist in general identification work of the Taxonomic Division.

K. A. Salman, formerly with the Massachusetts Agricultural College, has been appointed agent at the Bureau of Entomology, Forest Insects field station at Palo Alto, Calif., and reported for duty April 14.

Rodney Cecil, Bureau of Entomology, returned on April 28 to the field laboratory at Geneva, N. Y., where he will resume his studies on bean insects. He spent last winter at the field laboratory at Columbus, Ohio.

J. A. Stear, Entomologist at the Chambersburg laboratory of the Pennsylvania Dept. of Agriculture, resigned March 1st to begin work with the Koppers Coke Co. of Pittsburgh. He will be located at the Koppers Experimental Farm at Ligonier, Pa.

Field assistants, Bureau of Entomology, who have recently been appointed are W. I. Duplessis and G. H. York, for service at Alhambra, Calif., R. D. Church, at Walla Walla, Wash., R. J. Severance at Toppenish, Wash., and H. L. Dees, at Grand Bay, Ala.

C. F. Stahl, Bureau of Entomology, Chadbourn, N. C., visited Hammond, Baton Rouge, and other points in the strawberry-growing region of Louisiana, April 17 to 19, to ascertain whether the strawberry root apid was a serious hindrance to the production of strawberries there.

Dwight F. Barnes, Bureau of Entomology, formerly on the staff of the Gipsy-Moth Laboratory, Division of Forest Insects, was transferred April 1, 1930, to the laboratory for the study of dried-fruit insects. Mr. Barnes left Washington for Fresno, Calif., on April 19th.

K. L. Cockerham and O. T. Deen, of Biloxi, Miss., spent the interval from March 18 to March 25 in northwestern Florida, scouting for the wireworm, *Heteroderes laurentii*, in the course of which they visited Escambia, Santa Rosa, Okaloosa, Walton, Holmes, Jackson and Bay Counties.

Dr. Walter Carter, Bureau of Entomology, who has been in charge of the investigations of the sugar-beet leafhopper, with headquarters at Twin Falls, Idaho, since its inauguration in 1925, resigned March 21, to accept a position as entomologist with the Pineapple Growers' Experiment Station, University of Hawaii, Honolulu.

A branch office of the Yakima, Washington, laboratory of the Bureau of Entomology has been established at Wenatchee, Washington, for the study of the relation of woolly aphis and other insects to perennial canker. Mr. M. A. Yothers has been transferred from the Yakima to the Wenatchee laboratory to carry on these investigations in cooperation with the plant pathologists of the Bureau of Plant Industry.

Dr. C. I. Bliss, Bureau of Entomology, was transferred on March 5 to the new regional laboratory located at Whittier, Calif., where he will have charge of the technical phases of the investigations carried on there, especially those having to do with the resistance to hydrocyanic acid gas of scale insects affecting citrus.

During the latter part of January a shipment of several hundred pupae of the European earwig parasite, *Digonochaeta setipennis* was received at the Belleville Ontario Parasite Laboratory from the Imperial Bureau of Entomology. It is intended to liberate the flies reared therefrom in British Columbia.

At the request of the War Department, Dr. T. E. Snyder, Bureau of Entomology, left Washington on March 29 to inspect with a representative of the Forest Products Laboratory, military supplies of wood at arsenals in Rock Island, Ill., New Cumberland, Pa., and Springfield, Mass. These inspections are made periodically, to prevent serious accumulative damage by powder post beetles.

The Connecticut Tree Protection Examining Board held an institute for the instruction of tree workers at the Hotel Garde, New Haven, on February 26. The following Entomologists took part in the program: Dr. W. E. Britton, New Haven, Chairman; Professor Glenn W. Herrick, Cornell University, Ithaca, New York; Dr. E. P. Felt, Stamford, Conn; Mr. M. P. Zappe, Dr. R. B. Friend, and Dr. Philip Garman, New Haven.

Mr. R. E. Balch, Entomological Branch, who was recently appointed to the position of Entomologist in charge of forest insect investigations in the Maritime Provinces and the Gaspe Peninsula, with headquarters at Fredericton, N. B., reported for duty at Ottawa, on Feb. 10. Mr. Balch was formerly Agent at the Coeur D'Alene Station of Forest Entomology, investigating forest defoliating insects of the northern Rocky mountain territory.

On April 17, D. W. Jones, Bureau of Entomology, in charge of the parasite work of the European Corn Borer investigations, met in New York a shipment of parasites of the citrus black fly (*Aleurocanthus woglumi* Ashby), collected by C. P. Clausen in the Straits Settlements. He then accompanied this shipment to Cuba, where he will act in an advisory capacity in the establishment of the parasites in that island.

R. C. Brown, of the Bureau of Entomology, Gypsy Moth Laboratory, sailed from New York City on March 12 to return to his temporary headquarters in Budapest, Hungary. Before reaching Budapest he will visit Sweden in search of information regarding parasites of a sawfly, *Phyllotoma nemorata* Fall., which has recently attracted considerable attention as a leaf-miner of birch in Maine, New Hampshire, Nova Scotia, and New Brunswick.

In the month of April the following appointments were made in the Bureau of Entomology, Chas. L. Barnes, Junior Entomologist, for duty at Tempe, Ariz., Virgil F. Kent, Junior Entomologist, at Monroe, Mich., Lewis H. Colby, Agent, at Toledo,

Ohio, Miss Marydea Thomas, Under Scientific Helper, at Tempe, Ariz., W. W. Baker, field assistant, Puyallup, Wash., R. N. Lux, field assistant, Walla Walla, Wash, and J. T. Ray, field assistant at Tallulah, La.

A valuable collection of Philippine Island insects, formed by Dr. W. Dwight Pierce while he was employed as entomologist for the Victorias Milling Company, of the island of Magnos, has through the interest of Dr. Pierce been received by the Bureau of Entomology from that company. It contains many rare insects, and interesting material of early stages, and will be a valuable addition to the collections of the national Museum.

The Dominion Entomologist of Canada, Mr. Arthur Gibson, attended the 17th annual meeting of the New Jersey Mosquito Extermination Association which was held at Atlantic City, N. J., Feb. 12–15. By special invitation he presented a paper at the evening session Feb. 13 on "Mosquito Investigations in Canada during 1929." In company with Dr. T. J. Headlee he visited the Japanese Beetle Laboratory to discuss with officials there certain co-operative work to be conducted in 1930.

In anticipation of funds specificially appropriated for investigations of peach insects in eastern Tennessee, which are expected to become available July 1, the Bureau of Entomology is establishing a field laboratory at Harriman, in that State. H. G. Butler has been put in charge of it, and has been transferred from the Bureau's laboratory at Wichita, Kans. Mr. Butler has been succeeded at Wichita by Edwin W. Howe, a graduate of the University of California, who reported for duty April 10.

E. R. Van Leeuwen, in charge of general insecticide investigations, Japanese Beetle Laboratory, returned to the Laboratory on March 16 from a furlough of three and one-half months. During his absence from the laboratory Mr. Van Leeuwen was in charge of the Department of Entomlogy at the Davey Institute of Tree Surgery, Kent, Ohio. A course in shade-tree insects was given to the freshman, and junior, and senior classes of the Institute by Mr. Van Leeuwen and his assistant, E. A. Sanford, of the Davey Tree Expert Company.

At a conference of the Council of the Northeastern Forestry Experiment Station held at Springfield, Mass., February 1, to discuss the need of research on forest insects, entomologists of the region were invited to attend and take part in the discussion. The following entomologists were present: Harold L. Bailey, Bradford, Vt., C. P. Alexander, K. A. Salman, H. J. MacAloney and H. L. Sweetman, Amherst, Mass., Mr. Nash, Augusta, Me., W. E. Britton and R. B. Friend, New Haven, Conn., H. L. McIntyre, Albany, N. Y., F. C. Craighead, Washington, D. C., A. F. Burgess and T. H. Jones, Melrose Highlands, Mass.

Preliminary to the organization of the Bureau of Entomology $100,000 Peach Moth work, a conference was held at Vincennes, Ind., April 4, when plans for the experiments were discussed. The attendence included S. C. Chandler, of the Illinois State Natural History Survey, Prof. J. J. Davis, of Purdue University, J. S. Houser, of the Ohio Agricultural Experiment Station, Prof. Leonard Haseman, of the University of Missouri, and Prof. W. A. Price, of the University of Kentucky, also Dr. F. H. Lathrop, Dr. B. A. Porter, R. F. Sazama, and W. P. Yetter, of the Bureau of Entomology, and several local fruit growers.

R. A. St. George, Bureau of Entomology, attended a meeting at the Forest Products Laboratory during the last week in April. This is a meeting held annually to

discuss the progress of forest research in the Forest Service and cooperating organizations. The Bureau of Entomology is chiefly interested in the development of plans for the economic survey provided for in recent legislation. An inventory of the forest resources of the country will be made, and an attempt to arrive at figures for depreciation due to insects and fungi will be part of the undertaking.

During the week of April 6 Dr. R. T. Cotton, of the Bureau of Entomology, was in Buffalo assisting in the fumigation of wheat with the ethylene oxide-carbon dioxide mixture. These fumigations were conducted under the direction of Laurel Duval, of the New York Produce Exchange. There were also present representatives of the Bureau of Chemistry and Soils and the Bureau of Agricultural Economics. During the week of April 21 Dr. Cotton and representatives of those Bureaus were present at Port McNicoll, Ontario, Canada, where over a million bushels of wheat were being fumigated with the ethylene oxide-carbon dioxide mixture.

On April 24 Perez Simons, W. D. Reed, and D. F. Barnes of the Bureau of Entomology visited Sacramento to attend the organization meeting of the entomologists and others interested in entomology in California north of the Tehachapi Mountains. About 65 were present. The name chosen for this organization, which is similar to the Entomological Club of Southern California, is the "California Entomological Club". Director Hecke delivered an address of welcome, and four papers were presented. The chief work of bringing about the organization has been done by Stewart Lockwood, formerly of the Bureau of Entomology, but now with the California State Department of Agriculture.

In view of the possible early removal of the smaller buildings connected with the Bureau of Entomology, and the resultant need of laboratory space elsewhere for workers who have been sheltered by them, the Bureau of Entomology Division of Deciduous Fruit Insects has leased quarters in Takoma Park, Md., at 7710 Blair Road. Accomodations at this address have also been provided for the scientific workers of the Division who have been quartered at Sligo, Md., and they are now transferring their equipment to the new laboratory. The workers who are moving from Washington include Dr. F. L. Campbell, H. H. Shepard, Charles Lukena, Miss Abby Holdridge, and Mrs. Bessie Bell.

The Deficiency Bill of the Bureau of Entomology carried $10,000 for experimental control of the spruce budworm in the Cody Canyon of the Shoshone National Forest. This is the east entrance to the Yellowstone National Park. A severe infestation of the spruce budworm has been progressing here for three or four years, and an attempt will be made to save the timber along the roadsides and around tourist camps by spraying with lead arsenate. From an investigational standpoint it is hoped that this work will demonstrate whether or not this insect, which feeds more or less concealed in the opening buds, can be controlled by arsenicals, and will determine the best time for application and the proper dosages.

Mr. Donald McCreary, a graduate of Iowa Wesleyan College and of the University of Maryland, has been appointed Research Fellow in the Department of Entomology of the University of Delaware, Agricultural Experiment Station, Newark, where he will conduct an investigation of oil sprays for control of the Oriental Peach Moth on peach and apple, sponsored by the California Spray Chemical Company thru the Crop-Protection Institute. Mr. L. L. Williams, Assistant Entomologist, continues in charge of the Entomological Laboratory at Camden, and Mr. William R. Haden,

a graduate of the University of Delaware, and Mr. Fred C. Daigh, a graduate of the University of Illinois, have accepted temporary appointments for the conduct of routine investigational work at Bridgeville and Newark respectively.

C. A. Bennett, Mechanical Engineer, of the Division of Agricultural Engineering, Bureau of Public Roads, who has heretofore been mentioned as cooperating with the field Laboratory at Tallulah in cotton-drying investigations, and having patented processes and methods devised there, was in Washington, D. C., from March 29 to April 18. Four patent claims, relating to his inventions, condensed into three public-service patents, have been granted, and a fifth claim appears to be on the way to recognition. While in Washington Mr. Bennett drafted four other claims for his division, and discussed matters pertaining to recent investigations in Mississippi.

H. S. Peters, detailed from the Division of Insects Affecting Man and Animals, left Washington April 14 for New York, where he took charge of the first consignment of *Microbracon kirkpatricki*, a parasite of the pink bollworm collected in Kenya Colony, Africa, and shipped through England to New York by the Imperial Bureau of Entomology. Mr. Peters carried the material in an iced container to El Paso, Tex., where it was delivered on April 17 to F. A. Fenton, in charge of research work on the pink bollworm. A second consignment of the parasites reached New York April 21 on the S. S. George Washington. J. L. Webb, of the Washington office, took charge of this shipment and arranged with the express company to forward it to Dr. Fenton at El Paso, the Company agreeing to keep the container supplied with ice en route. Dr. Fenton reports that the shipment was received in good condition.

Besides temporary field assistants, L. F. Steiner, D. W. Hamilton, and Francis Munger have been appointed for the experimental work on oriental fruit at Cornelia, Ga., and J. F. Cooper for that at Vincennes. W. P. Yetter has general charge of the experiments on control with bait traps, with headquarters for the present at Vincennes. The experiments at Cornelia will be under the immediate charge of Mr. Steiner, who is a graduate of Ohio State University and holds a Master's degree from that institution. For the past three years, as an employee of Purdue University, he has been in charge of investigations of the codling moth in south-central Indiana. Mr. Hamilton is a graduate of the University of Illinois and has done advanced work at that institution. Mr. Munger is a graduate of the University of Minnesota. Mr. Cooper is a recent graduate of the University of South Carolina, and for several years has been employed by the Bureau of Entomology on work with cotton insects.

As a result of efforts on the part of interested fruit growers, an appropriation of $100,000 was included by Congress in the First Deficiency Bill for additional work to be conducted by the Bureau of Entomology against the oriental fruit moth. Of this item $80,000 provides for large scale experiments with bait traps to be carried on in two different fruit sections, an area including 500 acres of peaches to be baited in each section. It is hoped that those experiments will answer the question which has long existed as to whether the use of bait traps over a wide area would give better results in the control of the oriental fruit moth than when a limited area of only a few acres is baited, in which case the surrounding unbaited area is in comparison very large. Irrespective of the results in terms of practical control, which of course can not be predicted at the present time, this investigation offers an opportunity to obtain much additional information about the oriental fruit moth. Mr. W. P. Yetter has been placed in charge of the bait work. In addition to the maintenance of bait

traps over large areas, important detailed experimental work is also contemplated. The localities selected for the work to be conducted during the season of 1930 are Cornelia, Ga., and Vincennes, Ind. The remaining $20,000 of this money is to be used to strengthen the work with parasites and insecticides and for a study of the ecology of the oriental fruit moth. The work with parasites and ecology is to be headquartered at Moorestown, N. J., under general supervision of Mr. L. B. Smith, and will constitute an enlargement of work already being conducted by Dr. H. W. Allen. The insecticide studies will be conducted at Vincennes, Ind., under the direction of Dr. F. H. Lathrop.

Apicultural Notes

On March 20 Jas. I. Hambleton, Bureau of Entomology, visited the vicinity of Westminster and New Windsor, Md., on an inspection trip for the location of an experimental apiary.

Dr. A. P. Sturtevant and J. E. Eckert, of the Bureau of Entomology Intermountain Bee Culture Field Station, Laramie, Wyo., have reported that the annual meeting of the Colorado Honey Producers' Association, held in Denver on March 4 and 5, which they attended was one of the best meetings ever held by the association. Both Dr. Sturtevant and Mr. Eckert appeared on the program and discussed various phases of the experimental work now under way at the Laramie Station.

On the afternoon of March 26 several members of the staff of the Bee Culture Laboratory attended a very interesting lecture by Dr. Karl von Frisch of the University of Munich, on the behavior of the honeybee. Doctor von Frisch's lecture, given in the auditorium of the Engineering Building at Johns Hopkins University was well illustrated with excellent lantern slides and marvelous motion-picture films, showing the behavior of the honeybee in its reactions to colors, odors, and taste. Even the evidence of "language" in the honeybee was clearly shown by the use of films.

Dr. Karl von Frisch, of the University of Munich, who has been in this country on a lecture tour, visited the Bee Culture Laboratory of the Bureau of Entomology on April 29 with Dr. N. E. McIndoo. Doctor van Frisch is an outstanding authority on the behavior of the honeybee, and is the author of numerous zoological papers. On Monday, April 28, he gave an interesting paper before the National Academy of Sciences on the sense of hearing in fishes. This lecture was well illustrated with a remarkable motion-picture film showing the response of fish to various sounds and exemplified graphically the advantage of using motion pictures to report the results of experiments in which the behavior of an organism is involved. On the evening of the same day a dinner, attended by a number of the members of the Bureau of Entomology, was tendered Doctor van Frisch at the Cosmos Club, after which before an appreciative audience, he gave a most interesting lecture on the language of the honeybee, illustrated by motion pictures. Doctor von Frisch sailed for Germany on May 2, after completing an extensive tour, during which he visited and lectured before a number of the principal eastern and mid-western universities. The following were among those he visited: Universities of Wisconsin, Minnesota, Indiana, Ohio State, Western Reserve, Buffalo, Yale, Harvard, and Johns Hopkins.

Horticultural Inspection Notes

Mr. B. R. Anderson was transferred from El Paso to Ysleta, Texas, on March 17, to take charge of the latter port.

Mr. W. R. Sudduth was transferred from El Paso to Fabens, Texas, on March 23, to take charge of the latter port.

Mr. L. A. Roberts was transferred from El Paso to Columbus, New Mexico, on April 22, to take charge of the latter port.

Mr. R. B. Lattimore was transferred from Brownsville, Texas, on March 20 to Presidio, Texas, to take charge of that port.

Port inspectors William J. Ehinger and Jose A. Ramos were transferred from El Paso, Texas, to Philadelphia, Pa., on February 1.

Dr. S. B. Fracker spent May 2 and 3 in New York City and on Long Island conferring with inspectors of the Administration concerning narcissus and transit inspection.

The States of Illinois, Iowa, and Wisconsin have recently amended their alfalfa quarantines to bring up to date the list of counties designated as infested with alfalfa weevil.

Eelworm infestations (*Tylenchus dipsaci*) have been recently found by inspectors and collaborators of the United States Department of Agriculture in narcissus in Alabama and Oregon.

Mr. N. A. Eaton, Junior Plant Quarantine Inspector who has been stationed at the port of Philadelphia for some time resigned on March 26, to accept a position with the State of Virginia.

Mr. C. P. Trotter is being transferred from the port of San Juan, P. R., to take charge of the plant quarantine work of the United States Department of Agriculture at the port of Sabine, Tex.

Mr. A. A. Stalmach was transferred from Brownsville, Texas, on March 24, to Rio Grande City, Texas, to take charge of the Plant Quarantine and Control Administration's activities at the latter port.

Mr. George J. Nicolaides was appointed a Junior Plant Quarantine Inspector at the port of New York, effective May 1, to fill the vacancy caused by the transfer of Mr. A. B. Wells to Philadelphia on the same date.

Mr. M. S. Mirimanian who has been employed for several years on the Pink Bollworm Project of the Plant Quarantine and Control Administration, was transferred to the Mexican Border service on April 1 and has been assigned to the port of Brownsville.

Mr. Clyde N. Partington, formerly employed in the Division of Forest Pathology, Bureau of Plant Industry, was transferred to the Port Inspection Service on May 9 and has been assigned to the port of Astoria, Oregon.

Mr. S. A. Rohwer spent most of April and the first half of May conferring with field employees of the Plant Quarantine and Control Administration in Texas, Arizona and California, and visited a number of other field stations of the Administration en route.

Mr. Ezekiel Rivnay who was employed as a Junior Plant Quarantine Inspector at the port of Philadelphia on October 12, 1929 was transferred to the Mediterranean Fruit Fly Project on February 10, 1930 and assigned to duty in Florida.

Mr. C. E. Baker, who has been engaged in white pine blister rust work for the Federal Bureau of Plant Industry and the Plant Quarantine and Control Administration for several years, resigned on February 28 to accept an appointment with the Conservation Department of New York.

The State of Pennsylvania has issued Quarantines No. 22 and No. 23 on account of Japanese Beetle and European corn borer, respectively, and established regulations thereunder in line with recent revisions of Federal regulations on account of infestations with these insects.

Mr. N. Rex Hunt, In Charge Import Division, left Washington on March 12 for the Pacific Coast to inspect special permit material being grown in the states of California, Oregon and Washington. Mr. A. G. Webb, in charge of the port work at Seattle, Washington, has been assisting Mr. Hunt in this work.

An informal conference was held in the office of the Plant Quarantine and Control Administration in Washington on April 10 to discuss various details connected with the enforcement of the Japanese beetle quarantine regulations. Representatives of all the States (except Pennsylvania) quarantined on account of this pest were in attendance.

The following members of the Japanese beetle staff who were temporarily assigned to assist in the enforcement of the Mediterranean fruit fly quarantine, have now returned to their former duties: J. R. Cassel, W. N. Dobbs, W. L. Gormley, H. C. Helliwell, J. W. Kelley, E. S. Russell, and W. J. Thomason.

Dr. John Gray, who has been on leave of absence from his position in the Entomology department of the University of Florida during the past year, resigned as Agent of the Plant Quarantine and Control Administration on May 1 to accept appointment in investigational work at Moorestown, N. J., under the Federal Bureau of Entomology.

The State of Tennessee has revoked the State quarantine on account of the chestnut blight which has been established since 1919 to prevent the movement of chestnut nursery stock from a number of eastern and southern states. This lifting of the former embargo is due to the presence of the chestnut blight in eastern and central Tennessee.

Louis A. Catoni, Chief Plant Quarantine Inspector of the Territorial Department of Agriculture and Labor, San Juan, P. R., reports that there are now on duty under his direction, in addition to an assistant and two port inspectors at San Juan, one inspector for each of the ports of Fajardo, Jobos, Arroyo, Ensenada, Arecibo, Mayaguez, Ponce and Aguadilla.

Mr. Richard Faxon, formerly Chief of the Bureau of Plant Industry of Ohio, and during the past two years a member of the Plant Quarantine and Control Administration staff at New York City, has been transferred to the port of San Juan, P. R., on a three-year assignment. He was accompanied on the trip to Porto Rico on May 15 by Mr. E. R. Sasscer, who is expected to return in about two weeks.

The State of Texas requires that citrus seed originating in the State of Florida which is to be shipped into Texas must be dipped in a 1-1000 corrosive sublimate solution and then shipped direct to the Texas Department of Agriculture, where it is refumigated with hydrocyanic acid gas. This restriction is reported to have been placed on citrus seed shipments "to eliminate any possible chance of any insects being carried into the main citrus belt of Texas."

Extensive orchard inspections have been carried out by the Texas State Department of Agriculture during the past year, especially for the purpose of determining whether there is any possibility of the Mediterranean fruit fly having arrived in the State. The groves were also inspected at the same time for the Oriental peach moth and the phony peach disease. No infestations or infections of either of the insects or the disease named were discovered in the State.

Dr. R. W. Leiby, State Entomologist, Raleigh, N. C., has been appointed Secretary of the National Plant Board to hold office until the next regular meeting of the Board. Doctor Leiby succeeds Dr. W. A. McCubbin, who resigned as Secretary of the National Plant Board when he was appointed by the Plant Quarantine and Control Administration to take charge of the certification of Florida products for intrastate and interstate movement under the Federal and State quarantines on account of the Mediterranean fruit fly.

Effective March 18, 1930, the State Department of Agriculture of California revised the State ozonium root rot quarantine (No. 13) to add Arkansas to the States quarantined and to modify the certification and permit requirements formerly in effect. All nursery stock, trees, plants, shrubs and vines (not including such materials free from soil) from the States of Arizona, Arkansas, Texas, Oklahoma and New Mexico, must be certified as grown on premises free from the rot.

The following who have been engaged during the past few months in car-cleaning and cold sterilization supervision, transit inspection, or phony peach disease activities, for the Plant Quarantine and Control Administration, were transferred to the Bureau of Plant Industry for the summer: F. J. Baker, W. E. Bradder, C. M. Chapman, W. J. Cullen, L. M. Culpepper, E. J. Ethridge, N. H. Harpp, L. W. Hodgkins, A. J. Lambert, C. O. Peterson, F. H. Rose, R. E. Wheeler, and G. M. Whiting.

On April 10, 1930, the Plant Quarantine and Control Administration issued a "List of True Bulbs, Corms and Tubers" as PQCA-274. The list was issued for the information of shippers within the areas regulated under the provisions of the Japanese beetle quarantine. The latest revision of the regulations supplemental to that quarantine exempts such true bulbs, corms and tubers from the requirement of certification when they are shipped without fibrous roots and are free from soil, except that this exemption does not apply to dahlias.

The Domestic Quarantine division of the Plant Quarantine and Control Administration has established regional offices for the administration of transit inspection and the enforcement of the blister rust and phony peach disease quarantines at 1511 Manhattan Building (431 So. Dearborn St.) Chicago; 641 Washington St., New York City; 332 State Capitol, Atlanta, Ga.; and 406 Federal Building, Spokane, Washington. Mr. J. M. Corliss is in charge at Chicago, Mr. C. B. Beamer at New York, Mr. G. W. R. Davidson at Atlanta, and Mr. C. R. Stillinger at Spokane.

"A Summary of State and Territorial Plant Quarantines Affecting Interstate shipments," has been prepared by Miss M. A. Thompson of the Plant Quarantine and Control Administration, and is now in proof. It is expected to be available for distribution as Miscellaneous Circular No. 80 during June or July. It is being prepared in loose leaf form and is expected to be kept up-to-date by the issuance of revised sheets to those who secure copies of the complete summary. The synopses of the regulations have been approved by the plant quarantine officers of the States concerned.

A public hearing was held in the office of the Plant Quarantine and Control Administration, 1729 New York Avenue, N. W., Washington, D. C., on April 24, 1930, for the purpose of considering the advisability of extending the phony peach disease quarantine to the State of Mississippi. At this hearing the State of Georgia was represented by Mr. M. S. Yeomans, State Entomologist, and the State of Mississippi by H. H. Kimball, Chief Inspector, State Plant Board of that State. The hearing was also attended by a number of representatives of the Federal Department of Agriculture. No action has yet been taken as a result of this hearing.

Three terminal inspection points for nursery stock and other plant materials are now being maintained by the State Department of Agriculture of Wyoming. The inspection at Casper is carried on by Mr. Krueger; that at Laramie by Mr. Crawford and that at Sheridan by Mr. Stocker. During the past year 1756 shipments were received at these points, of which four were returned to the shipper, five destroyed on account of infection or infestation, and one taken in violation of the Federal white pine blister rust quarantine. Mr. A. G. Stephens, Cheyenne, Wyo., is in charge of quarantine enforcement and nursery inspection activities. Forty-four nurseries are licensed in the State.

The Texas State Department of Agriculture on May 5 issued quarantine proclamations numbered, 29, 30, 31, 32, 33, 34, 35 and 37, prohibiting the entry from Florida of various kinds of citrus nursery stock and other fruit and ornamental trees and shrubs, on account of scaly bark, citrus canker, white fly and a number of other designated insect pests and plant diseases. It is stated that one of the reasons for issuing these new proclamations is that "the validity of State Proclamations 18, 19, 20 and 21, designed to regulate the movement of citrus fruit and nursery stock have been questioned because they were not re-proclaimed by the Commissioner of Agriculture under Chapter 15, Acts of the Second Called Session of the 41st Legislature."

An informal conference to consider the potato wart situation, with particular reference to Pennsylvania, Maryland and West Virginia, was held in the office of the Plant Quarantine and Control Administration at Washington on April 12. Those present included Professors C. E. Temple and R. A. Jehle of Maryland; Dr. T. L. Guyton of Pennsylvania; Professor W. E. Rumsey of West Virginia; Drs. K. F. Kellerman and Freeman Weiss of the Bureau of Plant Industry, and Drs. W. A. McCubbin and S. B. Fracker of the Administration. A decision was reached to continue the present State quarantine and suppression policies for the coming year and to consider the subject further either early in the spring of 1931 or in the fall of 1930.

The California sweet potato weevil quarantine (No. 9) was revised by the State Department of Agriculture of that State, effective March 12, 1930, to withdraw from the area designated as infested, the counties in Oklahoma which had previously been included within such area. The present order prohibits the entry of sweet

potato tubers, plants and cuttings, morning-glories and yams, from the following described territory for any purpose; the States of Florida, Texas, and Louisiana; the Counties of Jackson, George, Hancock, Harrison and Pearl River, in Mississippi; the Counties of Baldwin, Jefferson and Mobile in Alabama; and Charlton County, Georgia. Special certification is required for above materials (except morning-glories) when shipped from points outside the infested areas.

Recent orders issued by the Plant Quarantine and Control Administration with respect to the transportation of Florida host fruits and vegetables are as follows: PQCA-272—"Modification of Production, Harvesting and Shipment Restrictions on Florida Host Fruits and Vegetables"; PQCA-273—"Spraying Requirements for Grapes Produced in the Eradication Area of Florida"; PQCA-275—"Reshipment of Certain Florida Host Fruits and Vegetables Within Southern and Western States Authorized"; PQCA-276—"Elimination of Summer Host Plants in Eradication Area of Florida Will not be Required"; PQCA-279—"Re Disposition of Ripening Citrus Fruits, Avocados, Persimmons, Host Vegetables and Bananas in the Eradication Area of Florida During the Host Free Period"; PQCA-280—"Shipment of Florida Peppers and Lima and Broad Beans to Central States, and Reshipment of Host Vegetables Within Northern and Central States Authorized."

PQCA-277, issued by the Plant Quarantine and Control Administration on April 22, 1930, authorizes the importation under permit until further notice subject to treatment under the supervision of representatives of the Administration, in quantities not to exceed 100,000 to each permittee, of the following varieties of narcissi, namely: Spring Glory, Glory of Sassenheim, Victoria, Emperor and Golden Spur. The notice states that it appears from evidence before the Administration that the present supply for planting purposes of these varieties has been considerably reduced with the result that planting stock is apparently not obtainable in sufficient quantities to meet present propagating needs. It was further ordered that since the need for further importation of the propagating stock of Gloriosa, Minister Talma, Pheasant's Eye and Tresserve still exists, these varieties may continue to be imported within the 25,000 quantity limit which applies to varieties other than those first named.

Mr. Lee A. Strong, Chief of the Plant Quarantine and Control Administration, has issued, effective July 1, 1930, a list of representative genera of plants subject to importation under special permits, with the maximum yearly quantity limit given for each genera. In connection with this order, Mr. Strong stated that "ten years have elapsed since this quarantine became effective and it is now believed that the horticultural interests of this country have had ample opportunity to build up stocks of standard varieties of plants and adjust their operations to the new conditions which followed the promulgation of the quarantine in 1919. It appears that this period of readjustment has largely passed, since most growers have recently confined their requests for special permit stock to small quantities of new species and varieties or novelties. It is evident, therefore, that there is no necessity for the continued assumption of needless pest risk through further importations of these restricted plants in such large numbers as has heretofore been permitted."

The Agricultural Appropriation Bill for the Department of Agriculture as passed by the House of Representatives includes for the work of the Plant Quarantine and Control Administration, the following items: $73,000 for general administrative purposes; $720,000, in addition to an unexpended balance of $10,000, for the en-

forcement of foreign plant quarantines; $40,000 for transit inspection; $497,000 for the control and prevention of spread of the pink bollworm; $65,000 for the control and prevention of spread of the Parlatoria date scale; $34,300 for the control and prevention of spread of the Thurberia weevil; $647,500 for the control and prevention of spread of the gipsy moth and brown-tail moth; $1,000,000 for the control and prevention of spread of the European corn borer; $475,000 for the control and prevention of spread of the Japanese and Asiatic beetles; $10,000 for the control and prevention of spread of the white pine blister rust; $12,000 for the control and prevention of spread of the phony peach disease; $115,000 for the control and prevention of spread of the Mexican fruit worm; $20,000, in addition to an unexpended balance of $10,000, for export certification; a total of $3,708,800. The Senate added as an amendment an item of $6,900,000 for Mediterranean fruit fly work. At the time of writing (May 13) the bill is in conference committee.

Mr. J. S. Woodard, Chief of the Nursery and Pecan Division of the State Department of Agriculture of Texas, reports that the division under his direction is organized as follows for the season 1930: There are seven regular nursery inspectors, namely, J. C. Stephens, Tyler, Tex.; R. F. Campbell, Alvin, Tex.; W. J. Abbey, San Antonio, Tex,; R. T. Milner, Dallas, Tex.; E. A. Schattenberg, Harlingen, Tex.; C. D. McGehee, Lubbock, Tex., and Walter T. McKay, Austin, Tex., in addition to W. W. Kirkpatrick, San Saba, Tex., who devotes a part of his time to nursery inspection. For the inspection of pecan nurseries, both for insects and as to trueness of variety name, two inspectors are employed, namely, Frank J. Willmann and L. D. Romberg, of Austin, Tex. The inspection of citrus nurseries is carried out largely by the citrus canker inspectors who are: E. W. Halstead, Mission, Tex.; Hal F. Halstead, Mission, Tex.; J. K. Thompson, Edinburg, Tex.; W. P. Daniel, Donna, Tex.; G. F. Wilson, Brownsville, Tex.; B. F. Bryant, Palacios, Tex.; and J. L. Summers, Laredo, Tex. There are now 1726 nurseries and greenhouses in Texas to inspect, with something like 500 sweet potato inspections in addition to the nursery work. Narcissus bulbs are grown on ten different premises, all of which were granted certificates showing freedom from infestation, except that one variety on the premises of one company was required as a condition of certification to be given the hot water treatment because of the presence of an infestation of *Aphelenchus subtenuis*.

Notes on Medical Entomology

Merwin Monagin has been appointed Field Assistant, Bureau of Entomology, dating from March 8, and assigned to the field laboratory at Uvalde, Tex.

T. E. McNeel, of the Bureau of Entomology field laboratory at Mound, La., has returned to Zellwood, Fla., to continue the study of mosquitoes of the genus Mansonia, which he began last year.

On April 2, F. C. Bishopp, Bureau of Entomology went to Baltimore to confer with Dr. Baer, of Johns Hopkins University in regard to the rearing of blow-fly larvae, which Dr. Baer is using for treatment of certain bone diseases.

H. E. Parish, formerly on the staff of the Mississippi State Plant Board, has been appointed Assistant Entomologist, Bureau of Entomology, and assigned to the field laboratory at Menard, Tex. He reported there for duty March 27, and will relieve E. C. Cushing, who will soon go to Alaska to continue the investigations of reindeer insects begun by W. E. Dove in 1929.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

VOL. 23 AUGUST, 1930 No. 4

Proceedings of the Fifth Annual Meeting of the Cotton States Branch, American Association of Economic Entomologists

The fifth annual meeting of the Cotton States Branch was held at Jackson, Miss., on February 6 and 7, 1930. The attendance was greater than at any previous meeting of the Branch, there being 92 names on the attendance record. The program required the time of two long sessions, and special attention was given to the results of investigations of insects attacking crops in the Southern region. Due to the number of papers submitted for the program, it was necessary to limit some of them to a reading of only the abstracts. Of special interest was the address by Wilmon Newell on the Mediterranean Fruit Fly. The president of the parent association, Franklin Sherman, was in attendance, and since he was not present at Des Moines when he was elected, he was duly inducted into office at the Cotton States Branch meeting. The entomologists were guests at banquets on the nights of February 6 and 7, and also at a reception given by the Governor of Mississippi. The meeting was concluded on February 8 with a tour to the Delta Laboratory at Tallulah, Louisiana, where all phases of the cotton insect work was explained and a program provided by the members of that Laboratory. The attendance at Tallulah was 40. The visiting entomologists were guests of the Tallulah Chamber of Commerce for dinner.

PART I. BUSINESS PROCEEDINGS

The meeting was called to order by Chairman B. R. Coad at 2:00 P. M. on February 6 in the Edwards Hotel at Jackson, Miss. The following members were present:

Amsler, F. P., Gulfport, Miss.
Anderson, W. E., Baton Rouge, La.
Arnold, G. F., A. & M. College, Miss.
Bentley, G. M., Knoxville, Tenn.
Bibby, F. F., College Station, Tex.
Bieberdorf, G. A., Stillwater, Okla.
Bishopp, F. C., Washington, D. C.
Bond, G. T., Laurel, Miss.
Bondy, F. F., Tallulah, La.
Bradley, G. H., Mound, La.
Brunson, M., Picayune, Miss.

Carpenter, H. H., Houston, Miss.
Cassidy, T. P., Tucson, Ariz.
Chance, O. M., Jackson, Miss.
Coad, B. R., Tallulah, La.
Cockerham, K. L., Biloxi, Miss.
Colmer, R. P., Moss Point, Miss.

Deen, O. T., Biloxi, Miss.
Deen, R. B., Tupelo, Miss.
Dietrich, Henry, Lucedale, Miss.
Douglass, N. L., Grenada, Miss.
Douglas, W. A., Crawley, La.

English, L. L., Spring Hill, Ala.
Ewing, K. P., Tallulah, La.

Fenton, F. A., El Paso, Texas.
Folsom, J. W., Tallulah, La.

Gaines, R. C., Tallulah, La.
Goodgame, L. J., Aberdeen, Miss.
Gray, W. L., Natchez, Miss.
Grimes, D. W., Durant, Miss.
Grimes, M. L., Meridian, Miss.

Hamner, A. L., A. & M. College, Miss.
Harned, R. W., A. & M. College, Miss.
Hester, J. G., A. & M. College, Miss.
High, M. M., Gulfport, Miss.
Hinds, W. E., Baton Rouge, La.
Hines, Chesley, Yazoo City, Miss.
Hull, F. M., College Station, Tex.

King, M. V., Mound, La.
Kislanko, J. P., Wiggins, Miss.

Langston, J. M., A. & M. College, Miss.
Larrimer, W. H., Washington, D. C.
Lee, J. E., Poplarville, Miss.
Leiby, R. W., Raleigh, N. C.
Livingston, B. P., Montgomery, Ala.
Lyle, Clay, A. & M. College, Miss.

Maloney, G. A., Tallulah, La.
Marcovitch, S., Knoxville, Tenn.
Milton, Jack, Corinth, Miss.
Moreland, R. W., Tallulah, La.
Moznette, G. F., Albany, Ga.
Myers, L. E., A. & M. College, Miss.
McEvilly, J. E., McComb, Miss.
McGehee, T. F., Holly Springs, Miss.
McNeel, T. E., Mound, La.

Newell, Wilmon, Gainesville, Fla.
Noble, L. W., Tallulah, La.

Osterberger, B. A., Baton Rouge, La.

Parish, H. E., A. & M. College, Miss.
Peets, N. D., Brookhaven, Miss.
Price, B. C., Mobile, Ala.

Reed, T. B., Picayune, Miss.

Sasscer, E. R., Washington, D. C.
Sherman, Franklin, Clemson College, S. C.
Smith, F. A., Senatobia, Miss.
Snapp, Oliver I., Fort Valley, Ga.
Spencer, Herbert, Baton Rouge, La.

Worthington, G. I., Cleveland, Miss.

Yeomans, M. S., Atlanta, Ga.

Report of the Treasurer

Balance on hand, Feb. 6, 1929		$ 6.72
Refund from parent association for expenses for year ending Feb. 5, 1929		23.73
Contribution		1.00
1929 annual dues from 41 members		41.00
1930 annual dues from 1 member		1.00
Paid out		
Stamped envelopes	$22.03	
Printing announcements and programs	6.25	
	$28.28	$73.45
Balance on hand Feb. 6, 1930	45.17	
	$73.45	

Report of the Secretary

The number of members in the Cotton States Branch on December 31, 1929, was 216. There was a net increase of 11 members during the year, after dropping those who had moved out of the Branch territory or who were dropped by the parent association for non-payment of dues. This increase in membership was due largely to the continued effort on the part of the Branch to secure new members. The net increase in 1928 was 23. During the last three years the membership has grown from 158 to 216, after dropping those who had moved out of the Branch territory during that period or who had not kept up their dues in the parent association. So the number of new members added to the Branch roll during the last three years was even more than the number represented by the increase in the Branch membership.

The number of members by states at the close of 1929 was as follows: Texas 45; Louisiana 38; Mississippi 34; Florida 22; North Carolina 17; Tennessee 17; Georgia 14; Alabama 11; South Carolina 9; Arkansas 7; Oklahoma 2. The following states showed net increases during the year: Texas 10; Louisiana 4; Alabama 2; South Carolina 2; Arkansas 1; Georgia 1. These states showed net decreases: Mississippi 4; Florida 2; Tennessee 2; Oklahoma 1. There was no change in the number of members in North Carolina.

There are now 209 entomological workers in the 11 Cotton States who are not members of this Branch. Many of these are eligible, and members are urged to assist in continuing our efforts to strengthen our Branch by increasing the membership.

In accordance with the recommendations of the committee on policy which were adopted at our last annual meeting, your Secretary advised each member of the Executive Committee of the Association of Southern Agricultural Workers that more time is needed for our sectional meeting and requested permission to schedule sectional meetings for the mornings if necessary. That committee considered this matter at their meeting in Atlanta, Ga., on last April 5. They decided that it would be better not to have sectional meetings in the mornings, but that full time and attention be given to the general broad phase of agricultural development in the South, during the morning sessions, and that the afternoons, and if desired the evenings, be given to sectional meetings. However, they decided to schedule general sessions for the Jackson meetings during the mornings only, so that both afternoons and evenings may be devoted to sectional programs if desired.

In December, 1929, a notice in regard to the Jackson meeting was sent to each member of the Branch, and a program for the meeting was mailed to each member during the latter part of January, 1930. After the last annual meeting a copy of the financial statement of the Branch was sent to our members.

At the last final business session of this Branch, it was ordered that the annual dues shall be $1.00, and the Treasurer was instructed to mail annually to each member a notice of the dues and a statement of the financial condition of the Branch. This notice was mailed to each member on last May 2, and to date only 41 of our 216 members have paid their 1929 dues. Members in arrears are requested to pay up promptly. Dues for 1930 are now payable.

Chairman Coad announced the committee appointments as follows: Nominations, W. E. Hinds, G. M. Bentley, and Franklin Sherman. Resolutions, J. W. Folsom, R. W. Leiby, and R. W. Harned. The

committee on policy consisting of R. W. Harned, Oliver Snapp, and J. W. Folsom and the committee on publications consisting of Herbert Spencer and Oliver Snapp were continued by motion and vote. W. E. Hinds called attention to a cotton insect exhibit for the Chicago Century of Progress Exposition in 1933. The Branch approved cooperation with this project and named W. E. Hinds chairman of a committee to get up the exhibit. By motion and vote the following were appointed to assist with this work: B. R. Coad, R. W. Harned, and G. A. Maloney.

Final Business

The final business was transacted late in the afternoon of February 7. Chairman Coad called for the report of committees.

Report of the Committee on Policy: This committee recommended (1) That a time limit of ten minutes shall be set for each paper in the future. (2) To be eligible for acceptance, the title of a paper must be sent to the secretary before January 1, together with an estimate of the time required for the presentation of the paper. (3) The Secretary shall, as usual, send invitations to all members to participate in the meetings, but shall mention the action taken by the Branch if the second recommendation is approved. These recommendations were adopted by motion and vote.

The Publications Committee called attention to the fact that an abstract must accompany all papers presented for publication, and instructed those who read papers at the meeting to send them with abstracts to the Secretary at the earliest date if they had not already been turned in.

The following report of the Resolutions Committee was accepted and adopted by motion and vote:

(1) We were especially pleased to have in attendance our colleagues from Washington: E. R. Sasscer, W. H. Larrimer, and F. C. Bishopp.

(2) The banquets given by the Commercial Members of the Association of Southern Agricultural Workers and by the Chilean Nitrate Educational Bureau added greatly to the enjoyment of the meetings.

(3) Thanks are due to the local committee and to the management of the Edwards Hotel for effective and courteous assistance of many kinds; also to many individuals and organizations who have helped to make our meetings a success.

The following report of the Cotton Insect Exhibit Committee was adopted by motion and vote:

A meeting of the Committee was held at Jackson on the morning of February 7 and a general discussion of the exhibit of cotton insects resulted in the following suggestions:

1. That the Mexican cotton boll weevil be made the principal species and central theme of this exhibit.

2. That as a background on the walls of the exhibit room, if three walls are available therefor, there should be in the center an outline map of the Cotton Belt extending westward to include Texas. On this map may be shown by 5-year intervals the advance lines of the boll weevil and in various sections of the Cotton Belt (somewhat in the style of some of the old Spanish maps) small scenes typical of various parts of the Cotton Belt, these scenes fading out at the edges. On the left hand wall possibly a typical scene of the old time cotton plantation before the coming of the boll weevil, with negro cabins and families and cotton field typical of that period. In contrast to this on the right hand wall the typical new scene of the up-to-date cotton farmer of the present time illustrating various phases of the application of the extension program in cotton production. This would include something of livestock, legumes, etc., and a comparison of typical cotton fields as recommended at the present time with their yields.

3. In connection with this exhibit we would like to have an enlarged model of the Mexican cotton boll weevil, female, which might show general facts of structure more plainly than the observer would see under a microscope. If this were prepared with the wings spread, it might be suspended as if in flight. In addition to this there should be enlarged models of the developmental stages: egg, larva and pupa also, leading up to the adult.

4. Probably a series of wax models might show well the cotton bud in its development through the square age and typical damage thereto by the weevil; the bloom shown as a section and the relationship of the floral parts to the ovary explained, and also the fully grown, but unopened bolls with typical weevil injury thereto.

5. In some way, and probably by placards and diagrams, the development of the Farm Demonstration work and the present Extension Service should be shown as an outcome of the boll weevil fight. Similarly there is a direct relationship to the tick eradication movement and its present high degree of exemption from tick infestation.

6. The economics of the boll weevil fight may be shown in summary through the effect upon prices for cotton and cotton seed; the volume and value of the cotton crop for the country; the farmers' income from cotton; the relationship to the living standard of the farmer and the

health of his family, and the development of public schools, improved roads, etc.

7. The development of the cultural control methods for fighting the weevil which are fundamentally important in increasing yields and decreasing weevil damage.

8. The development of direct methods of weevil control, including particularly the use of poisons such as calcium arsenate and the machinery for applying these poisons to cotton. In this exhibit would probably be shown typical machines for hand dusting, the saddle gun, probably the latest type of light engine driven duster, and finally a model of the insecticide-dusting airplane. This model is already available.

9. Probably as a wall-case exhibit there should be a series of specimens of the principal cotton insect pests including the cotton leaf worm, the pink bollworm, the cotton plant louse, the cotton flea hopper, cotton boll worm, etc.

10. Among contributing factors the work of the plant breeder has developed many new varieties which are far superior to old varieties and have helped to meet boll weevil conditions. Comparative exhibits of photographs of plants or actual plant specimens, and of bolls and of lint should be shown with the increased value of the line for the longer staple varieties. The changes that have been made in spacing of cotton and its effect upon high yields per acre should be indicated.

Typical plants illustrating unpoisoned cotton which has been heavily infested by the boll weevil in comparison with heavily fruited plants of the same variety which have been protected by poison would be a striking feature of the exhibit.

11. For use in the rest room or moving picture room nearby, moving picture reels showing the various steps in the fight against the boll weevil are available and others bringing this subject up to date will be prepared.

12. Enlarged photographs, charts, diagrams, etc., will be used to show certain features in many phases of this exhibit.

13. If possible to include it, an economic summary showing the governmental expenditure in the weevil-control fight, possibly something of the state expenditures in this fight from the beginning up to date and the value of the results in the larger yields and more valuable crops of cotton; in relation to the U. S. manufacturers of cotton goods and the U. S. balance of trade, etc.

It is quite apparent that our difficulty will be to condemn, boil down, and simplify this exhibit so as to include the most striking features of

these many phases within the space allowed. Further suggestions, criticisms, or changes on the part of the members of the Committee or others interested are earnestly solicited.

The Nominations Committee presented the following names for officers during the ensuing year: Chairman, J. M. Robinson, Auburn, Ala.; Vice-Chairman, S. W. Bilsing, College Station, Texas; Secretary-Treasurer, Oliver Snapp, Fort Valley, Georgia. By motion and vote the report was accepted and the officers duly elected by casting a single ballot.

Upon motion of the Secretary, the Branch voted to hold the 1931 meeting in Atlanta, Georgia, at the time set for the annual meeting of the Association of Southern Agricultural Workers.

PART II. ADDRESSES AND PAPERS

THE ENTOMOLOGIST IN RELATION TO COTTON INSECT PROBLEMS OF TODAY

By B. R. COAD, *In Charge Cotton Insect Investigations, U. S. Bureau of Entomology*

ABSTRACT

Publicity given cotton insects in recent years has created an impression of great increase in damage, but statistics indicate that while there has been some little tendency of the sort, this impression has been largely created because the farmers have become more observant of their insect problems. Some form of reasonably profitable control measure is available for all major pests but recent developments producing overlapping infestations of several pests in the same field have brought about such a complicated situation that timely localized advice is frequently needed. The U. S. Bureau of Entomology has been testing an experimental cooperation with the research and extension workers in the States of South Carolina and Oklahoma where weekly field surveys of insect activity are made and used as a basis for prompt advice to the farmers. The experience gained warrants the belief that some similar system could be used to advantage in many other sections of the cotton belt.

Just what are insects doing to our cotton crop? It seems that each year we read and hear more of insect attacks here, there and everywhere throughout the Cotton Belt. As a result, we find an impression that there has been a tremendous increase in insect activities on cotton, and that the task of the farmer in raising cotton has become more difficult. This feeling has grown to the point where it is well to pause and consider carefully, balance the books as it were, and see what changes have taken place and how these affect the entomologists of the cotton states in their duties to the farmer.

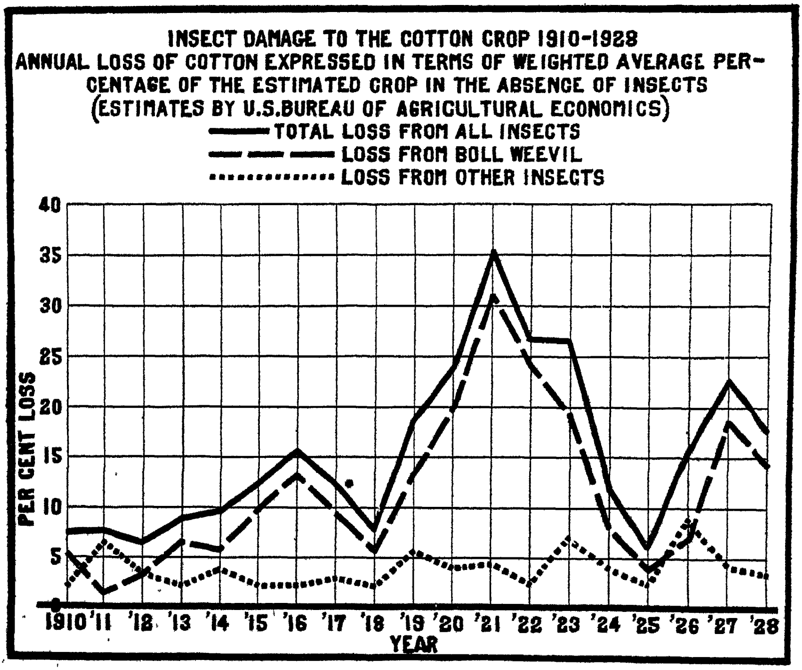
For the past score of years I have had the privilege of being in an office which serves as a sort of clearing house for insect questions and

complaints by cotton farmers. The first half of this period covered the final stages of the weevil's march across the Cotton Belt, and the boll weevil far overshadowed all other pests as a subject for discussion. In more recent years, however, there has been a remarkable change, and we hear more and more of other pests, until one would get the impression that the boll weevil has lost its prestige and that the future of the cotton crop was tottering before the threat of these other pests. We have attempted to analyze this situation and find just how far this feeling is justified.

At the outset, it immediately becomes obvious that this idea is due largely to reports originating on the farm. It is also equally obvious that the cotton farmer of today is a very different individual in his attitude toward entomological problems from the farmer of a score of years ago. For the past few years we have heard a great deal about the American people becoming "air-minded," but I wonder if many of us realize the fact that the cotton farmer is becoming "insect-minded." There is no question that the cotton farmer of today has more appreciation of his entomological problems and is more alert to detect insect attack than ever before. Consequently, damage that a few years ago was overlooked or vaguely attributed to weather or other causes, is now detected and the proper pests given the blame in an increasing proportion of cases. This change in attitude is easily understandable and is due to a combination of many causes. The educational activities of the Extension organizations of the various states and the Federal Government have had the greatest effect. In addition, we have a greater percentage of farmers with technical agricultural training. The spectacular battles being waged against some of our principal pests, or those threatening invasion, have had a great publicity value for entomology and have served to advertise the practical importance of entomological problems. In view of these increased tendencies toward observation and alertness, it is to be expected that there would be more talk of insect damage even without any actual change in the field situation. Consequently, this publicity becomes unreliable as an index to damage and it is necessary to seek further to find the true picture.

The best source of positive information we have, consists of figures furnished by the Bureau of Agricultural Economics of the United States Department of Agriculture. Each year this organization makes a careful estimate of the loss of cotton caused by all insects, and this loss is subdivided into that caused by the boll weevil and that caused by all other pests. The chart has been prepared to show these estimates for the period from 1910 to 1928. In interpreting this, it should be

remembered that the boll weevil did not complete its march across the Cotton Belt until 1922. At the beginning of the period under consideration, weevil damage and other insect damage total somewhat similar figures, but weevil damage soon left that of the other insects far to the rear. Then followed a period of recession in weevil activity, to be followed still later by another period of acceleration. Judging from the



relative positions of the curves, weevil publicity compared with references to other pests should have been about the same during the past few years as during the period from about 1916 to 1919, but, as has been pointed out, quite the opposite is true. This is easily accounted for by the fact that during the earlier period the weevil was still continuing to spread into new territory and we were confronted with the panic phase of publicity, which has not been encountered in the later years. Another important factor influencing this chart and its interpretation is the increased use of control measures for cotton pests which has taken place during the period covered. Not only have various indirect measures become standard practices, but direct control measures are now applied over enormous acreages both for the weevil and for other pests, and there is no doubt that without these measures, both direct and indirect, the loss figures of later years would be considerably higher than those shown.

Weighing the situation from every angle, it seems evident that there has been an increase in general insect activity on cotton but that this increase is probably not so great as would be thought judging merely from publicity. The problem then remains to see how this affects the duties of the Entomologists of the South.

Fortunately, the Entomologist now knows how to control, at least to a reasonable degree, practically all of our major cotton insects. It is true that many of these control methods are still in a developmental stage and that as time goes on they will be either modified or replaced by better ones, but the fact remains that we do know methods which are reasonably profitable and feasible. However, in the final analysis, the value of a control measure depends upon its suitability for use by the farmer and a method which yields perfect results under laboratory supervision but which is not subject to popular practical application may prove to be worthless. One great weakness of some methods for the control of cotton insects lies in their comparatively technical background and the fact that they can be used most successfully only with a thorough understanding of the fundamental principles involved and the exercise of intelligent discretion in their application. They would be much more useful if iron-clad, rule-of-thumb instructions could be issued to be followed under all circumstances but, unfortunately, this is not the case. At the same time the increasing insect-mindedness of the farmer makes him more capable of properly using these methods. Furthermore, there is a tendency on the part of any agricultural practice, regardless of whether it is insect control, cultivation or what not, to become standardized to the average conditions of the locality. In other words, given sufficient time, a practice is adopted which will yield the best average results over a period of years, although it may not be the one best suited to any one particular case which might be selected. Just now, we are passing through such a formative period and it is at such a time that the entomological and educational forces can be of most service to the farmers.

A few years ago it began to appear as if averaging or standardization of most of these control measures would be comparatively simple, but since then we have been greatly impressed with the complications which have arisen at numerous places throughout the Cotton Belt owing to overlapping infestations or, in other words, the simultaneous activity of several different pests. During recent years we have had insect control studies in several localities where as many as five different major pests affected the same field during the course of the season. Under such circumstances, control recommendations for any one individual pest

necessarily became influenced, and frequently completely changed, by the activities of the other pests. This makes a very complex situation to deal with and one which, in the light of our present knowledge, requires a rather high degree of technical observation, and we have not yet progressed to the point where control recommendations have been so simplified that the average farmer can deal with such a complicated problem to best advantage. This is a situation in which he needs immediate skilled advice based upon his localized conditions and as such problems have been impressed upon us, we have been attempting to devise some means by which such assistance can be rendered without requiring too cumbersome an organization or a prohibitive expense.

Fortunately, for reaching the farmers the research workers already have at their disposal a tremendous organization in the Extension forces of the South, and the problem resolves itself into one of securing the necessary timely and localized information, weighing and interpreting this, and then transmitting suitable recommendations through these forces. In development of such an idea, we have tried several experiments in cooperation during the past few years, particularly with the Experiment Station and Extension workers of the States of South Carolina and Oklahoma, where entirely different cotton insect problems are presented. In each of these states, the research and educational workers have combined forces and worked out a joint program, under which a few research workers lay out the state by insect zones and make regular surveys of insect activity in each of these zones throughout the season of battle. The work so far has been entirely on an experimental basis, the effort having been to ascertain the type of information needed, the man-power required, the best methods of dissemination of advice, etc., but, generally speaking, this information has been transmitted to a control headquarters about once a week, analyzed there, and timely advice immediately issued whenever and wherever it was required. The procedures followed have not been perfect and there is no doubt that further experience will result in making such a service more and more useful, but the results so far have been encouraging, and we feel that such a service could be developed throughout those sections of the Cotton Belt suffering greatest insect damage, at comparatively little cost and with great benefit to the farmers. We find that one research worker can keep up with a remarkably large territory, and with proper experience it is probable that from one to three such men could supply the information needed in almost any southern state. We have also been much interested in following the independent activities of the State Plant Board of Mississippi, which has taken advantage of the fact

that it has trained men scattered throughout the state, to utilize these men incidentally to their other duties, in assembling timely information on account of cotton insects. Undoubtedly there are many states in which such incidental service could be utilized at little or no additional expense.

Such surveys have a two-fold value. They not only serve to provide technical information to serve as a basis for timely advice to farmers but they also serve to call the attention of the research organizations which have been behind them to definite, specific research problems requiring investigation and to offer many clues to the worker in dealing with these problems. Consequently, it seems to us that the greatest single step which could be taken today toward further reducing the insect loss to cotton would be the widespread development of such organizations. Perhaps they would need to be permanent to deal with new insect problems and new aspects of old problems which may arise with changed production methods; if so their cost would be a splendid investment. On the other hand, it might be found that after a period of years there would be a sufficient averaging of problems, or what might be called an equilibrium of methods might be reached, and this special service would be no longer needed. Just now, however, there is certainly a crying need and the cotton farmer is in a receptive mood.

CALCIUM ARSENATE TESTS, 1929, A PROGRESS REPORT ON SMALL-SCALE TESTS COMPARING BOLL WEEVIL CONTROL WITH LUCAS' GREEN CROSS CALCIUM ARSENATE VS. A "STANDARD BRAND" OF CALCIUM ARSENATE

By W. E. Hinds, *Entomologist Louisiana Experiment Station*

Abstract

These two forms of calcium arsenate were tested in the field in various ways. The Lucas materials showed indications of some advantages in dusting qualities and in adhesion to cotton in spite of rains. It appeared to be slightly more efficient in reducing the percentage of squares attacked by the boll weevil in the plats dusted with this material and in the yield of cotton secured from an average of the four treated plats. In cage toxicity tests where weevils were exposed for twenty-four hour periods on dusted plants, the Lucas material gave an average mortality of 58% for the six successive periods of 24-hours exposure while "standard brand" calcium arsenate gave an average of 38%. These results were from three series of tests.

Early in the season of 1929 our attention was called to the advisability of conducting some tests with calcium arsenate materials which were being offered for sale in Louisiana for boll weevil control. The manufacture of calcium arsenate has been better standardized during recent

years than that of any other of our insecticide materials. However it is recognized that there is always a possibility of improving such materials in some respects so as to render them more efficient or more profitable in their use. Therefore arrangements were made to conduct a limited test of the Lucas Kil-Tone Special Calcium Arsenate in comparison with one of the widely used and generally satisfactory brands which for our purposes we will refer to as "standard brand" calcium arsenate.

One of the first demonstrations of a difference in physical qualities between such different brands of calcium arsenate consisted in throwing, or blowing a small amount of each against a plate glass show window. The "standard brand" material fell along the glass surface with very little adherence to the glass, while the Lucas material fell somewhat more slowly and showed a rather high degree of attraction to the glass. The difference in these two dust streaks was so apparent that it could be photographed easily with a hand camera.

This observation led to the first series of tests which consisted of duplicated applications of each dust to large panes of glass set vertically in the open field and then dusted. One glass in each pair was moistened slightly with the mist from an atomizer before the dust was applied. The other was dusted dry. These tests were kept under observation for the effect of winds, dews and rain for a period of about five days. On the third day there was a rainfall of .92 inch. This rain was of the heavy dashing type and washed off most of the dust. After the rain the largest residue of dust appeared to be on plate 1 which had been dusted dry with the "standard brand" of calcium. Very little dust adhered to plate 2 which represented the dew condition at the time of dusting. Still less residue appeared upon plates 3 and 4 which were treated respectively dry, and with dew, with the Lucas brand.

These tests were repeated and the results after another heavy rain were very similar to the series described above.

Applications to cotton were next in order and preliminary tests applied to adjacent rows showed that it was necessary to standardize the amount of dust applied to a given area in order to secure comparable tests. The physical qualities of the Lucas material were very evidently superior in fineness and even flow of material through the dust gun. This resulted in a considerably heavier application of the Lucas material being made where the usual throttle opening and crank revolution speed were maintained. Therefore, it was decided to use a "plunger type" of hand duster in these tests and the weight of dust discharged with each type of dust was correlated with the number of full strokes of the plunger required to throw out the same weight of material. The applications of

dusts in the test were then made so as to give a practically uniform amount of dust discharged upon each test plat.

In arranging the field tests to determine the effect of each type of dust upon boll weevil control under usual conditions, two rows of cotton were used. The arrangement of plats is shown below.

	Plat A	Plat B	Plat C	Plat D	Plat E
Row 1........	"Standard"	Lucas	Check	Lucas	"Standard"
Row 2........	Lucas	"Standard"	Check	"Standard"	Lucas

Each plat was 30 ft. in length. Plats 1-A and 2-A were dusted in the first adhesion test on July 1 and again on the 6th. In each of these tests the "standard" showed more conspicuously on the foliage before rains occurred but disappeared more completely during rains. In each test the adhesion of Lucas material was considerably more conspicuous after the rains fell. There was no burning from either dust.

Square infestation records were used as a measure of efficiency of each dust, and were taken by examining 100 squares in each plat in the usual manner. The first examination for square infestation was made before the first dust application and examinations were continued for two weeks after the last dusting. The examinations were started on July 11 and dust applications were made on July 11, 15 and 17, also rainfall occurred as follows:

SQUARE INFESTATION, DUST APPLICATION, AND RAINFALL THROUGH TESTS

July Dates	Dusted	Rainfall Inch	Square Infestation Records, % Check	"Standard"	Lucas
11.........	11	—	12.5	15.7	11.25
13.........	—	.24	—	—	—
15.........	15	.03	4.0	3.0	1.5
16.........	—	.46	—	—	—
17.........	17	—	—	—	—
18.........	—	.18	—	—	—
19.........	—	—	17.5	2.75	4.5
21.........	—	.02	—	—	—
24.........	—	.40	20.5	6.5	5.0
25.........	—	.37	—	—	—
27.........	—	.20	—	—	—
28.........	—	.20	—	—	—
29.........	—	.18	—	—	—
30.........	—	.14	—	—	—
31.........	—	—	65.5	44.0	36.0

An examination of the figures in the table indicates that the Lucas material reduced the square infestation somewhat more than did the "standard" material. Furthermore it appeared to maintain its advantage over the "standard" material quite consistently during the 2 weeks of very showery weather which followed the last dust application date.

While these tests were entirely too limited to justify any final conclusions therefrom, they did give an indication of advantage in favor of the Lucas material. Considering various factors which might be involved in securing this result, it appeared that the finer dusting quality of the Lucas material aided in securing a more even and efficient distribution of the dust through the plants and also there appeared to be superior adhesion and longer continued protection of the plant in spite of rains.

In order to check more carefully on the actual toxicity to weevils, a series of Cage Tests was started on August 1. The usual type of screen cages, about 4 ft. in each dimension and with a door opening so that the observer could enter the cage, was used. The plants to be treated were carefully selected, examined thoroughly to remove all weevils, the ground covered with white cloth so that weevils falling from the plants might be found, the plant dusted and the cage placed over it. Ten weevils were then placed in each cage on the plant. At the end of 24 hours an examination was made and all weevils removed, noting the number dead and the number alive. The living weevils were kept on fresh unpoisoned squares for 2 days longer and those dying meantime were presumed to have secured a killing dose of poison during their exposure in the cage and were, therefore, included in the final record of the number killed from each day's exposure on the plant. A fresh lot of 10 weevils was placed on the plant to test the proportion killed through the second day and so on for each succeeding day until the number killed became too small to be considered of value in the further protection of the plant.

It is not worthwhile to give all of the details of these tests which were repeated in three series. An average of all of the records is secured by averaging the proportion of weevils killed for each day of exposure to the dust during the 6 days for which each series was run. This average shows that the Lucas material killed approximately 58% of the weevils which were exposed to it for 24 hours only, while the "standard brand" of dust killed approximately 38% under the same conditions.

The final figures for yield at the end of the season were secured by making an accurate count of the number of bolls which had matured and had been picked out on each series of plats. The average number of bolls required to give 1 pound of seed cotton in this field was 75. The average number of bolls matured and picked, per plat length of 30 row feet, was as follows: Check 216; "standard brand" dust 263; Lucas special dust 283. The average yield per acre on this basis would be at the rate of 960 pounds of seed cotton for the check, 1170 pounds

for the "standard" dust and 1260 pounds for the Lucas dust. The "standard" dust showed a gain from 3 dustings amounting to 210 pounds of seed cotton per acre and the Lucas material showed a gain of 300 pounds per acre above the check and 90 pounds gain over the "standard" dust. Estimating the value of seed cotton at 6c per pound, it would appear that the use of Lucas dust, in this case, with 3 dust applications, was worth somewhat more than $5.00 per acre in net profit above the profit from the use of a "standard" brand of calcium arsenate.

This Progress Report is made at this time because we feel that these limited tests show "indications of superiority" in the Lucas brand of special calcium arsenate which justify much more extended investigation. The tests reported above were made by Mr. H. F. Stout under the writer's general direction.

NOTES ON *PARATHERESIA CLARIPALPIS*[1] VAN DER WULP, A PARASITE OF *DIATRAEA SACCHARALIS* FABR.

By H. A. Jaynes, *Associate Entomologist, Bureau of Entomology, U. S. Department of Agriculture*

Abstract

Observations are given on the life history of the dexiid parasite, *Paratheresia claripalpis* Van der Wulp, in Argentina and Peru. Notes are included on the varying percentages of parasitism on the different stages of the sugar-cane moth borer, *Diatraea saccharalis* Fabr. It has been found that this parasite can withstand cold storage when in the puparium, and that shipments can be made over long distances.

Collections were made during the year from August, 1928, to September, 1929, in Argentina and Peru of a dexiid fly parasite, *Paratheresia claripalpis* Van der Wulp, which attacks the sugar-cane moth borer, *Diatraea saccharalis* Fabr., and shipments of this parasite have been made from these countries to Louisiana. Inasmuch as some of the other countries growing sugar cane are considering the possibilities of importing this parasite, it may be well at this time to note some of the observations to date.

This fly was described by Dr. Townsend (3) and later he published a short account of its life history in Peru (4). It was also described from the Argentine by Dr. Bréthes as *Sarcophaga diatraea* (2). The synonomy has been noted by Mr. Box. (1)

[1]The fly has recently been called *Paratheresia signifera* Tns., but according to Dr. J. M. Aldrich the proper name is *Paratheresia claripalpis* Van der Wulp.

During the winter months in Argentina, as well as in the summer months, this parasite can be found in the larval, pupal and adult stages. However, the real hibernating stage is in the larval form within the host borer. Those parasites that do succeed in developing through to the pupa stage emerge on warm days, and, unless there follows a period of warm weather long enough to allow the flies to mate and larvaposit, they die without attacking a host. Along the coast of Peru the winter months are not severe enough to cause hibernation.

Even though the borer damage of the cane was very high at this time of the year, in some cases reaching 100% of the stalks and 50% of the joints infested, the actual number of borers present in the cane was relatively small. The proportion of good parasite puparia found was not exceeding 5% of the number of borers present. To obtain any large number of parasites at this period required a considerable amount of labor in cutting out borers.

Later, when the young cane was coming up, "dead hearts"[2] were cut out and examined for parasitized borers and fly puparia. Parasitism was found to run from 2% to 22.72% in Argentina. This included puparia found at the time and those developed later from the borers. In Cartavio, Peru, the percentage was found to be higher—in one field only 7%, but in three other fields the average was 32%, and this included only the actual puparia present and borers then showing signs of parasitism. The remaining borers which were saved for rearing were destroyed by a laborer by mistake. Even when the percentage of parasitism was as high as 30% or more it was necessary to cut from 8 to 10 "dead hearts" to obtain one parasite, as there were a number of "dead hearts" containing no borer or parasite, the borer having been killed by other causes or having left the plant.

By the end of December, 1928, corn was being cut green as fodder for cows in Tucumán, and upon examination it was found that certain fields were heavily infested with the moth borer. Below is a table showing all borers and parasites, including two species of hymenopterons obtained in 12 days from three different fields. No account was taken of the borer pupae and fly puparia from which adults had emerged, or borers and parasites killed by accident while splitting open the corn stalks. The percentages given are therefore merely approximate, and represent parasitism apparent only at the times of the examinations.

[2]A young sugar cane plant killed by a borer larva is called a "dead heart" because the central part of the plant, or "heart" dies first. These plants often have the outer leaves normally green, while the inner leaves are dry and dead.

PARASITISM OF SUGAR-CANE MOTH BORER IN CORN

Date	Living Borers	Parathere-sia puparia and larvae	Ipobracon cocoons (Hymenop.)	Bassus cocoons (Hymenop.)	Nema-todes	% Parasi-tism by Parathere-sia
Jan. 2..	62	38	4	–	1	36.19
Jan. 4..	167	39	9	–	–	18.13
Jan. 5..	178	40	4	3	–	17.77
Jan. 8..	177	46	1	2	1	20.26
Jan. 9..	309	64	5	2	1	16.79
Jan. 10.	163	41	–	–	–	20.09
Jan. 11.	336	125	–	–	1	27.05
Jan. 12.	487	273	1	4	–	35.68
Jan. 14.	234	201	6	1	–	45.47
Jan. 15.	477	217	2	3	–	31.04
Jan. 16.	237	233	9	2	–	48.44
Jan. 17.	272	143	5	7	–	33.48
	3099	1460	46	24	4	
Average of percentages						29.11

The fields varied considerably in the infestation of the borer and in the abundance of parasites. Some fields examined during the months of February and March had become almost ripe before they were cut, and often in such cases the number of borers present were very few, and if compared with the good puparia present the percentage of parasitism ran up to 80 or 90. The number of fly puparia from which adults had emerged also increased with the age of the corn, and old dried fields, or those containing ripened corn, contained practically nothing but empty parasite and borer pupae cases. From a field at Moncada, Peru, where a large number of puparia were obtained, 100 stalks of corn were examined. These 100 stalks had 75 good borers or borer pupae and 70 fly puparia or borers showing signs of parasitism, or a total of 48% parasitism. This no doubt would be higher if the 75 good borers had been kept until the parasites within them developed. Still other fields contained a very small number of parasites.

In certain fields where parasitism was high, a number of borers were found which contained two fly maggots. These would produce two good sized puparia if the host were of large size, but if small, they would give two small puparia. Three puparia have been found at times next to each other and appeared to be formed from one host, but not more than two maggots have been seen within a host.

From a little over 500 borer pupae collected, 15 fly puparia were obtained, or about 3%. The parasite larvae had no doubt been in the borer when it changed into the pupa stage.

In order to get some idea of how freshly formed puparia withstand cold storage compared with older puparia, 12 light colored or reddish puparia

and 12 dark or black puparia were selected from those obtained in corn on February 28th, 1928. Two light colored puparia were examined and found to contain pupae that were in the early stages of development, while the two dark ones contained pupae that were in the final form. The twenty remaining puparia were then placed in an ice-box having a temperature between 42° and 50°F. for one month, or until April 2nd. They were then put in plaster of Paris vials set on moist sand in the office. From the ten dark colored puparia, five flies or 50% emerged between April 11th and 22nd. From the ten light colored puparia, six flies or 60% emerged between April 19th and 22nd. The puparia were taken directly from the ice-box and put in vials on April 2nd, and the temperature of the room at the time was 75°F. The room temperature recorded during this time shows a maximum of 83°F. and a minimum of 61°F. with average maximum of 75.1°F. and average minimum of 68.3°F. the average mean temperature being 71.7°F. This indicates that the puparia can stand cold storage for a period of at least one month and still give 50% emergence, though it is admitted that these data are very meager. But from emergence obtained from material shipped to New Orleans, Louisiana, it was learned that the longer the period of cold storage, the less the emergence.

The following results are noted for the cooler months of the year concerning the length of period spent in the puparium. From 50 puparia that were formed on June 24th and 25th from full grown larvae collected in corn on June 23rd, at Cartavio, Peru, two flies emerged on the 1st of August, eight on the 2nd, and the rest followed within the next few days. Thus the pupal period was from 37 to 44 days. The temperature for the month of July was from 51.8°F. to 78.8°F. with an average minimum of 57.56°F., an average maximum of 71.06°F., and an average mean temperature of 64.31°F. The temperature in June was very little higher.

The efficiency of this parasite is greatly reduced by the fact that it is attacked in the puparium by secondaries. These secondaries were found only on rare occasions in Tucumán during the year reported upon. In Peru, however, the parasitism by secondaries was found to run as high as 14% in one lot of puparia. The species from Peru have not as yet been determined but two species have been determined from Tucumán; one as *Spilomicrus* sp. of the family *Diapriidae*, and the other as *Pachycrepoideus dubius* Ashm. of the family *Sphegegasterinae*.

The number of puparia sent from Argentina between January 24th and April 18th amounted to 7,146, while from Peru 27,754 were sent in June and July. The puparia were packed in damp sphagnum moss in

small tin boxes, a number of these boxes being packed in a strong wooden box about 12 by 9 by 7 inches. All shipments were sent by cold storage, the wooden boxes being placed in small ice-boxes from point of collection to steamship. On board they were placed in the vegetable room of the ship at a temperature usually between 36° and 40°F. The boats were met in New York and the parasites were sent by train in another ice-box from New York to New Orleans. As has been stated, the longer the puparia were kept in cold storage the less emergence was obtained. Shipments from Tucumán, Argentina, were en route about four weeks, while those from Salaverry, Peru, arrived after fifteen days. From one shipment from Peru Mr. T. E. Holloway has reported nearly 46% emergence.

This parasite, *Paratheresia claripalpis* Van der Wulp, can be obtained in large enough numbers both in Argentina and Peru to make shipments from which the emergence will be worthwhile if the puparia are not kept too long in cold storage.

Literature Cited

1. Box, H. E. On the Identity of the Common Dipterous Parasite of the Larva of *Diatraea saccharalis* Fabr. in the Northern Provinces of Argentina. Bull. Ent. Research, Vol. 20, Pt. 2, pp. 199–200. 1929.
2. Bréthes, Juan. Parasites and Hyperparasites of Diatraea saccharalis in Tucumán Sugar Cane. Bull. Ent. Research, Vol. 18, Pt. 2, pp. 205–207. 1927.
3. Townsend, C. H. T. New Masiceratidae and Dexiidae from South America. Jour. N. Y. Ent. Soc., Vol. 23, p. 65. 1915.
4. ——— Informe sobre Las Plagas de La Caña en Los Valles de La Costa Peruana. Revista de Agricultura y Ganaderia, Vol. 3, No. 32 pp. 661–666. 1926.

RECENT EXPERIMENTS WITH SOIL ANIMALS ATTACKING ROOTS OF SUGARCANE

By Herbert Spencer and Charles L. Stracener, *The Louisiana Experiment Station*[1]

Abstract

During 1929, the growth of sugarcane grown in large cylinders containing sterilized or unsterilized soil, and inoculated with soil animals, or the fungus *Pythium*, or both *Pythium* and soil animals was affected adversely by the activities of these biological factors. They reduced the weight of cane, length of cane, and sucrose content.

Confirmatory evidence was obtained, that the Collembolans, *Lepidocyrtus violentus* Fols. and *Onychiurus armatus* Tull., and the Symphylid, *Symphylella* sp. "pit" the roots and eat away the small feeding rootlets.

Lepidocyrtus and *Onychiurus* were found responsible for part of the unsatisfactory germination of planted sugarcane, by destructive feeding on the "eyes" (buds).

[1]Published by permission of the Director, Louisiana Experiment Station.

"Growth Failure" or "Root Rot" of sugarcane is characterized by unthrifty, stunted growth of the plants, and "pitting" and rotting away of the root system to such a degree that stools may be pulled out of the ground with little effort. Fields of cane affected in this manner are unproductive and unprofitable. The condition of "growth failure" is brought about by the activities of a group of biological factors, including fungi (*Pythium*) (1)[2] and certain soil animals (the Collembolans, *Lepidocyrtus violentus* Fols., *Onychiurus armatus* Tull. and the Smyphylid *Symphylella* sp.). Laboratory and greenhouse experiments by the authors, previously reported (2), indicate that the Collembolan, *Lepidocyrtus violentus* Fols. is largely responsible for "root pitting" and "root pruning" and also indirectly for some of the stunting of the parts above ground. *Onychiurus* and *Symphylella* damage the roots to a lesser extent.

TABLE 1. SOIL ANIMAL FIELD TESTS, 1929

Group	Number Cylinders	Treatment (Each cylinder)
Series I—Sterilized Soil		
1	7	none
2	5	*Pythium* added
3	5	*Pythium* 200 *Lepidocyrtus violentus* 200 *Onychiurus armatus* 200 *Symphylella* sp.
4	6	200 *Lepidocyrtus violentus* 200 *Onychiurus armatus* 200 *Symphylella* sp.
5	6	200 *Lepidocyrtus violentus*
6	6	200 *Onychiurus armatus*
7	6	200 *Symphylella* sp.
Series II—Unsterilized Field Soil		
8	7	none
Series III—Air-dried Field Soil		
9	2	none
10	3	200 *Lepidocyrtus violentus*
11	2	200 *Onychiurus armatus*
12	2	200 *Symphylella* sp.

However, it was considered advisable to confirm these results by studying these soil animals, and also *Pythium* under controlled conditions in sugarcane fields, so the following tests were planned and executed cooperatively by the Entomologists and Plant Pathologists of the Experiment Station:

Sheets of 28 gauge galvanized flat iron, 24 inches by 96 inches, were crimped and the ends riveted together to form cylinders with open ends.

[2]Numbers refer to literature cited on page 684.

Holes were dug in a sugarcane field to receive these cylinders, so that they were six feet apart, center to center, and so that six inches of the metal stood up above the ground level. Forty-one of these cylinders (Series I) were filled with sterilized field soil, seven (Series II) with unsterilized field soil, and nine (Series III) with air-dried field soil. Each cylinder was planted during October 1928 with sugarcane of the variety P. O. J. 213. The soil animals were placed in certain of these cylinders, other cylinders were inoculated with cultures of the fungus, *Pythium*, others received both *Pythium* and soil animals, and others were left uninoculated, for comparison.

For sterilizing the soil two large boxes were constructed, were lined with sheets of galvanized flat iron, and were fitted with perforated galvanized iron pipes in the bottoms (Pl. 22, figs. 1, 5). Through these perforated pipes, live steam at 100 pounds pressure was forced into the soil, which in fifteen minutes reached temperatures above 95° C. The steaming was kept up for 1½ or 2 hours, and the soil was handled subsequently with steam sterilized shovels, and was placed in the cylinders while still very hot.

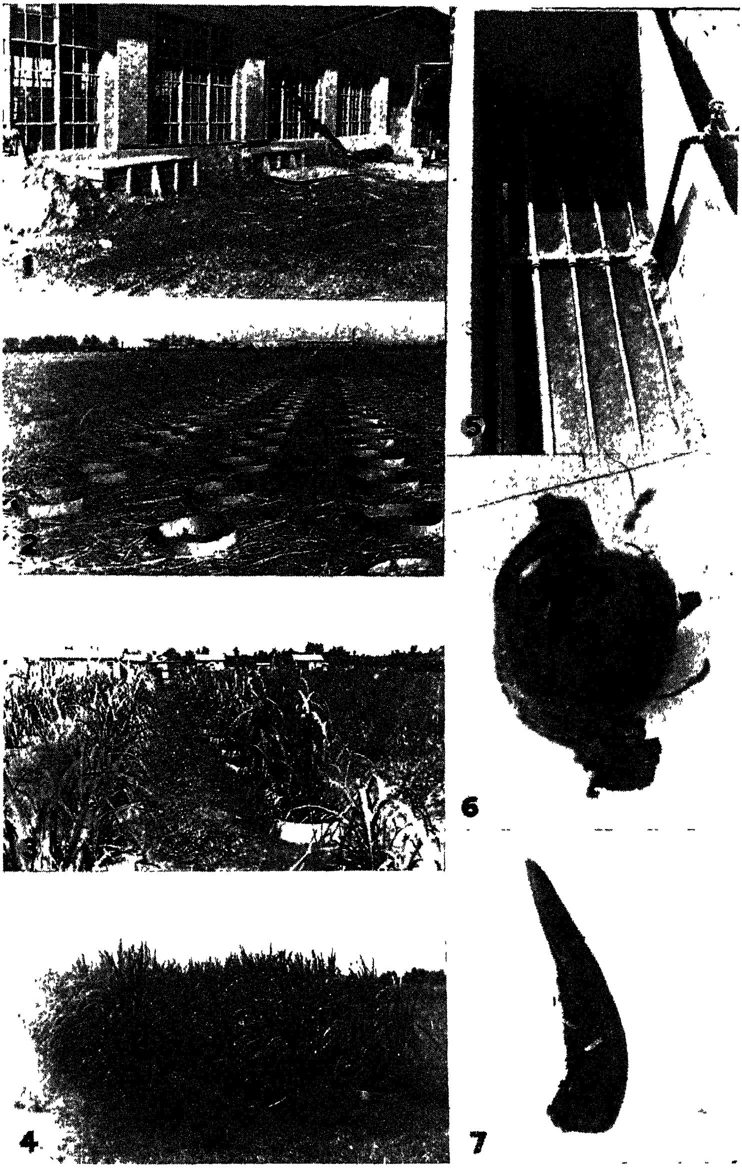
In the early spring, the sugarcane sprouted to a satisfactory stand in all but one of the cylinders. After "stooling-out," the number of canes per cylinder averaged more than twenty. During the growing season measurements of growth were made at monthly intervals, and in December the canes were cut, were weighed, and sucrose analyses were obtained. The final measurements and results are tabulated in the following table:

TABLE 2. SOIL ANIMAL FIELD TESTS, 1929, FINAL MEASUREMENTS

Group	Treatment	Average Sucrose	Growth Ratios Length	Growth Ratios Weight
	Series I—Sterilized Soil			
1	none	13.27	100%	100%
2	*Pythium*	12.96	89%	98%
3	*Pythium* and Soil Animals	12.49	86%	89%
4	Soil Animals	12.99	87%	82%
5	*Lepidocyrtus*	13.33	84%	78%
6	*Onychiurus*	12.85	87%	84%
7	*Symphylella*	13.24	100%	95%
	Series II—Unsterilized Field Soil			
8	none	11.41	52%	41%
	Series III—Air-dried Field Soil			
9	none	11.94	75%	60%
10	*Lepidocyrtus*	11.89	77%	64%
11	*Onychiurus**	10.19	61%	44%
12	*Symphylella*	12.39	78%	64%

*One cylinder replanted.

Plate 22



1—Boxes for the steam sterilization of soil· 2—Cylinders of sterilized soil, in which sugarcane has been planted; 3—Half-grown sugarcane in soil cylinders; 4—Nearly mature sugarcane in the soil cylinders; 5—Inside of soil sterilizing box, showing arrangement of perforated steam pipes; 6—Bud from planted sugarcane; the center eaten by Collembolans, *Onychiurus armatus* Tull. Germination is prevented by such injury; 7—Bud scale showing springtail injury and two specimens of *Onychiurus*.

The cylinder in which the sugarcane failed to germinate (in Series III, Group 11) was examined carefully during May. When the seed pieces of sugarcane were dug it was discovered that the "eyes" (buds) had been eaten by the springtails, *Onychiurus* to such an extent that they could not sprout (Pl. 22, figs. 6, 7). *Onychiurus* individuals were found inside of the buds, actually at work eating the green portions of the bud scales. This discovery led to bud examinations in several districts where the germination was unsatisfactory; planted cane was dug, and the findings tabulated:

TABLE 3. SUGARCANE BUD INJURY BY INSECTS

Locality Louisiana	Buds Examined	Buds Uninjured	Buds Rotted by Fungi	Buds Attacked by Insects	% Buds Attacked by Insects
Baton Rouge..	778	71	211	496	63%
McCall.......	2586	102	1429	1044	40%

TABLE 4. INSECTS FOUND IN INJURED SUGARCANE BUDS

Total number of Insects		122
Onychiurus armatus Tull.	56	
Lepidocyrtus violentus Fols.	26	
Fly larvae	8	
Termites	3	
Miscellaneous (scavengers mostly)	29	

The possibility of attack by the springtails being secondary to processes of decomposition was carefully considered and efforts were made to determine the true relation of causal agent to injury in every bud examined. The conclusion was reached that the springtails were primary agents, and that various rots, fly maggots and scavengers followed the springtails, doing further damage.

The writers wish to express their appreciation of the cooperation of Dr. C. W. Edgerton, Dr. E. C. Tims and other members of the Department of Plant Pathology, Louisiana Experiment Station.

SUMMARY

Under controlled conditions in a sugarcane field, with cane grown in large cylinders, the soil animals *Lepidocyrtus violentus* Fols., *Onychiurus armatus* Tull. and *Symphylella* sp., working together, caused a marked reduction in growth and final weight and a slight reduction in percentage of sucrose.

Sugarcane in cylinders inoculated with the fungus *Pythium* was affected similarly, and to approximately the same extent.

The growth and yield of sugarcane in cylinders inoculated with both *Pythium* and the soil animals was poorer.

Of the three soil animals, *Lepidocyrtus violentus* was the most injurious, *Onychiurus armatus* next, while very little damage could be attributed to *Symphylella*. The two springtails were found capable of affecting germination adversely, by eating portions of the buds and bud scales.

LITERATURE CITED

1. EDGERTON, C. W. and E. C. TIMS. Investigations on the Sugar Cane Disease Situation in 1925 and 1926. La. Experiment Station Bulletin 169. 1927.
2. SPENCER, HERBERT and CHAS. L. STRACENER. Soil Animals Injurious to Sugarcane Roots. Annals of Entomological Society of America—XXII, No. 4; 641–649. 1929.

THE VELVET BEAN CATERPILLAR AS A PEST OF SOY BEANS IN SOUTHERN LOUISIANA AND TEXAS[1]

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ABSTRACT

An attack on soy beans by the velvet bean caterpillar, *Anticarsia gemmatilis*, is reported, together with observations on the life history, natural enemies, and control measures. The application of a "light" or eighty per cent brand of sodium fluosilicate was found to be very effective in destroying the larvae.

Soy beans are grown throughout southern Louisiana, parts of Texas, and elsewhere, as a forage crop, and as a valuable legume in rotation with rice and other crops. The plants are also sometimes turned under in the fall as green manure, or cut and dried for feeding during the winter months.

The most serious insect pest found on soy beans in Louisiana prior to 1929 was the striped blister beetle.[2] Adults of this species appear most abundantly during July and August, and can be successfully controlled by applications of sodium fluosilicate as recommended by J. W. Ingram in U. S. Department of Agriculture Leaflet No. 12. The insect on soy beans attracting most attention during 1929 was what is known as the velvet bean caterpillar,[3] and it was found possible to control it by the use of the same chemical. As a similar infestation may recur in future years, it seems desirable to publish the information now available.

[1]The results here recorded were first published in a brief and popular manner in the Rice Journal of Crowley, Louisiana, in the number for December, 1929. This was published in the last part of November, 1929.

[2]*Epicauta lemniscata* Fab.; order Coleoptera, family Meloidae.

[3]*Anticarsia gemmatilis* Hübner; order Lepidoptera, family Noctuidae.

TYPE OF INJURY. The larvae of this night-flying moth are hearty feeders. They begin feeding on the tender leaves near the top of the plant. After the top leaves have been destroyed, the older leaves near the bottom of the plant are devoured. Still further, when all the leaves have been eaten, the tender parts of the stems are eaten away. Where a heavy infestation occurs, the larvae hollow out the ends of the stems, eat the buds from the stalks, chew off the branches and small bean pods completely, and sometimes gnaw the outside wall from the main stalk. The plants are, of course, ultimately killed.

FOOD PLANTS. In southern Louisiana, in 1929, the larvae fed only on soy bean plants, except for occasional slight feeding on cotton. After the green, tender parts of soy beans had been totally destroyed, the larvae marched into neighboring cotton fields and fed slightly. Pupae were found in cotton fields only where the cotton was grown very near to soy beans and after the soy beans had been completely denuded. The most "viney" varieties of beans were preferred by the larvae. It is thought by the writer that this was due to the fact that the stems and leaves of the "viney" varieties are more succulent, that the moths find better hiding places in their luxuriant foliage, and that these varieties mature later than the other varieties. In every case the "viney" soy beans were infested first, but the infestation spread rapidly to all other varieties. Careful observations were made in the fields where cotton and soy beans, kudzu vine (wild) and soy beans, cowpeas and soy beans, and velvet beans and soy beans were growing side by side or very near each other. No feeding or specimens could be detected on any of these crops other than soy beans except on cotton as mentioned. No kind of grass or weed was attacked whether growing in soy bean fields or elsewhere. In Florida, however, Watson[4] records velvet beans, kudzu vine, and horse beans as food plants.

DISTRIBUTION. This insect does not survive the winter in the United States except possibly in extreme southern Florida, according to Watson, who states that the moths migrate northward "each summer from the southern end of the peninsula or perhaps from Cuba." In the summer of 1929, the insect was widely distributed over southern Louisiana and southeastern Texas. The first infestations were noted near Napoleonville and New Iberia, La., about the middle of August. By the middle of September the infestation had moved westward approximately 250 miles by way of Lafayette, Crowley, Jennings, and Lake Charles, La.,

[4]Watson, J. R. Control of the Velvet Bean Caterpillar. University of Florida Agricultural Experiment Station Bulletin No. 130, pp. 45–58, 9 figs., 1916.

and Beaumont, Texas, to the vicinity of Nome, Texas, which is about 15 or 20 miles west of Beaumont. The infestation ranged some 8 or 10 miles south of the more or less parallel east and west line. These larvae have been reported as far north as Colfax, La., which is near the center of the State.

This infestation was the first in Louisiana to be serious enough to attract the attention of entomologists. In previous years, during the late fall, caterpillars of some kind have injured the foliage of soy beans very slightly, but there is no evidence to show that *Anticarsia gemmatilis* was responsible for the injury.

Life History. The adult of the velvet bean caterpillar, which is a dirty-brown moth, made its appearance in southern Louisiana about the middle of August. The moths, when disturbed, have a very swift flight. It is extremely difficult to see them when they are resting close to the soil as at this time the wings are opened in a position almost at right angles to the thorax and the body is pressed to the earth.

The moths usually deposit eggs singly on the under side of the leaves, but eggs are sometimes deposited on the upper side. Often only one egg can be found on a single plant, and again single eggs may be found on several leaves of a plant.

The eggs hatch in from three to five days. The larvae feed on the soy bean leaves for about three weeks. They actually spring into the air and throw themselves about when disturbed, and can be recognized by the general colorings and lines of the body as described on another page. When these caterpillars are handled they eject a brownish yellow fluid from the mouth.

When fully grown, they usually fall to the ground, burrow underneath the surface, and pupate. A small percentage of the larvae pupate on the plants, pulling together the sides of the leaves so as to form pupation inclosures, but this happens only in the lesser infestations. In heavy infestations no leaves are left available on the plants for pupation inclosures and all of the larvae pupate in the soil. A cell of earth is constructed at a depth of from one-fourth inch to 2 inches under the surface of the soil, and here the pupation period is spent. As many as 22 pupae were found in 1 square foot of soil in the Crowley section of southern Louisiana during 1929, when the average number of pupae per square foot in that section was found to be 13. Around New Iberia, La., the infestation was at least as heavy. Moths emerge from the pupae during the latter part of August and the early part of September, in from 6 to 10 days after pupation.

In Southern Louisiana, three distinct generations occurred in 1929. However, moths in migration continually deposited eggs, and young larvae from these could be found mixed with the older larvae at all times until the soy beans had been destroyed.

The first observed injury from larvae occurred about the middle of August. Moths from the first brood of larvae had emerged and were ready to lay eggs by the second week in September.[5]

DESCRIPTION. The egg, which is white, is slightly oval, from 1 to 1½ millimeters in greatest diameter, and has a rather shiny appearance. Eggs are deposited singly on the leaves of the food plants.

The larva reaches an average length of 37 millimeters, or about 1½ inches. The markings vary. The ground color of the larva is black or nearly black, except that some specimens have a grass-green color instead of black. Dark stripes alternate with lighter and even with white ones, and run the full length of the body. A stripe in the middle of the back, or dorsal surface, is always light, usually of a light green. This is bordered on each side with a broad dark stripe. From this to the ventral surface there may be one light stripe, or three light stripes alternating with dark ones. In the latter case the narrow dark stripe nearest the ventral surface is light brown. Spots around the setae, or hairs, are not prominent, but they are still darker than the dark stripes. The ventral or under surface is never striped and is always dark. The legs are lighter in shade than the rest of the ventral surface. Specimens in alcohol have a greenish instead of a black appearance.

The pupa averages 18 millimeters or about three-fourths inch in length. It is dark brown.

The moths average 37 millimeters or about 1½ inches across the outstretched wings and 12 millimeters or about one-half inch from head

[5]The following data on temperature, humidity and rainfall at Crowley, La., will indicate the weather conditions for the period during which the insect was most injurious.

For August, 1929, the average maximum temperature was 91.29°F., with 94°F. as the highest daily maximum. The average minimum was 72.29°F., with 63°F., as the lowest daily minimum. The average mean temperature was 81.79°F. The average relative humidity, according to wet and dry bulb readings, was 68.3 per cent. The rainfall was 2.87 inches, which included two rains of over an inch. Twelve days were more or less rainy, the other days being usually clear.

For September, 1929, the average maximum temperature was 87.86°F., with 93°F. as the highest daily maximum. The average minimum was 67.3°F., with 57°F, as the lowest daily minimum. The average mean temperature was 77.58°F. The average relative humidity was 65.8 per cent. The rainfall was 2.40 inches, 11 days being more or less rainy, but the heaviest rain being only 0.54 inch. The other days of the month were usually clear.

to end of abdomen. They are grayish brown, although through a hand lens the wings have a peppered appearance, black specks showing on a lighter surface. A line, which may be either lighter or darker than the rest of the wing, extends from wing tip to wing tip, running half way up the wings so as to form a segment of a circle when the moth is at rest, with the wings arranged fan shaped. This line, which is about a fourth of a millimeter in width, may be edged on each side with a parallel line which is lighter in color. The part of the wing on the caudal side of this line is of a darker brown than is the side nearest the head. Just below the line, and near the abdomen, there are two black dots on each wing. These are edged caudad, or toward the rear, with yellow, another sprinkling of black sometimes appearing caudad of the dash of yellow. The wings are bordered with a brown or yellow line, and are heavily fringed with gray or brown. On the under side of the wings is a row of white dots, consisting of seven dots to each wing. The row of dots appear about 2 millimeters or a twelfth of an inch from the caudal end of the wings.

NATURAL ENEMIES. The most effective natural enemies in southern Louisiana are birds. In fields, especially near the marshes and in the rice section of Louisiana, great flocks of birds congregate. The most numerous is the upland plover,[6] which is gray with a touch of white at the throat. It is very wild upon arrival in the fields but grows tamer if protected. It is possible sometimes to walk within 20 feet of this bird without disturbing it. It is often called "papabot" and sometimes "cherou." The "rice bird," or redwinged blackbird,[7] the English sparrow,[8] and the killdeer[9] have also been found by the writer to consume large numbers of the larvae. Other birds recorded[10] as enemies of the velvet bean caterpillar, although not observed by the writer, are the bobolink,[11] field sparrow,[12] and mockingbird.[13]

Young bullfrogs have been seen to catch the larvae and eat them until sometimes they get so full that they look as if a pressure pump was responsible for their inflated condition.

Such insects as wasps, robber flies, various Hemiptera, ground beetles, and fire ants feed very readily upon the larvae. On several occasions the writer has observed a thread-waisted wasp, *Sphex pictipennis* (Walsh), capturing larvae. Owing to the violent movements of the

[6]*Bartramia longicauda* (Beckstein).

[7]*Agelaius phoeniceus* (L.) [8]*Passer domesticus* (L.) [9]*Oxyechus vociferus* (L.)

[10]Watson, J. R. University of Florida Agr. Expt. Sta. Bul. 130, p. 56, June, 1911, and Jour. Econ. Ent. 9, pp. 526–527, December, 1916.

[11]*Dolichonyx oryzivorus* (L.) [12]*Spizella pusilla* (Wilson). [13]*Mimus polyglottos* (L.)

caterpillars when any object approaches them, this wasp did not fly directly to a caterpillar, but first alighted on the plant and then decided what larva to attack. It then flew to a leaf above the chosen caterpillar, opened its mandibles wide, and made a flying tackle on the larva and they both fell to the ground in a terrific struggle. The wasp was invariably victorious and soon began to climb up some object in order to get a flying start to carry its huge load away.

So far as is known at this writing, the only true parasite of *Anticarsia gemmatilis* is a small hymenopterous insect. It is not known whether this parasite attacks the larva or the pupa, but it emerges from the pupa. It has been determined by Miss Grace A. Sandhouse as *Brachymeria ovata* (Say).

A fungus disease[14] is sometimes a valuable factor in controlling outbreaks of this insect. One field in Iberia Parish, Louisiana, was completely freed of the caterpillars by this disease. The dead larvae often hang to the branches and leaves and have a greenish white appearance. It is not safe to rely upon this disease to save a soy-bean crop, because the plants may be severely and sometimes fatally injured before the fungus gets a start.

EXPERIMENTS IN CONTROL. The following experiments were conducted on soy beans at the Rice Experiment Station, Crowley, La., and acknowledgment is made to Mr. J. M. Jenkins, Superintendent, Rice Experiment Station, for his suggestions and cooperation in trying out the different control measures.

Owing to the very delicate nature of soy-bean leaves, it was something of a problem to find a poison which would kill the caterpillars without harming the plants. Experiments were conducted with calcium arsenate as a dust and with lead arsenate as a spray. The infestation appeared so suddenly that only these two insecticides, which were all that were available locally, could be tested. When the caterpillars eat leaves treated with arsenicals they of course die, but because of the fact that arsenicals kill soy beans, their use results as injuriously, in most cases, as the defoliation caused by the insect. As much as 5 per cent of lime was mixed with calcium arsenate, but very serious burning still occurred.

A standard nicotine spray was tried and, although no burning resulted, there was a very low percentage of kill. The addition of soap to the spray did not cause enough to adhere to the leaves to give good results.

Pure hydrated lime was used as a dust with no success.

[14]*Botrytis rileyi.*

Poisoned bran mash was used experimentally and gave a very low percentage of kill. Both wheat bran and alfalfa meal were used as ingredients of the mash, but neither gave promising results.

Since the soy-bean plants are able to withstand floods, it was thought that possibly the soil might be flooded and the pupae drowned. According to J. M. Jenkins, these plants are not injured by water standing over the soil for a period of 48 hours. Plots consisting of several acres were flooded for 48 hours and the pupae examined were found to be still alive and apparently not injured by the water.

Undiluted sodium fluosilicate of the brand sold by manufacturers as "light," which is from 80 to 84 per cent pure, has given excellent results when dusted on the plants at the rate of 10 to 12 pounds to the acre. The percentage of kill in every case has been from 90 to 100 per cent, more frequently 100 per cent. The larvae die in less than 24 hours after application.

Mixtures of 1 part hydrated lime to 4 parts of sodium fluosilicate, and 1 part of hydrated lime to 7 parts sodium fluosilicate were not satisfactory.

From preliminary experiments, it appears that the moths are attracted very little to lights.

Recommendations

1. Dust infested fields with sodium fluosilicate, preferably a "light" or 80 per cent brand. The lighter brands give as satisfactory results as do the heavier brands and are more economical to use. A hand duster, such as is used for dusting small plats of cotton, is satisfactory.

This dust should be applied at the rate of from 10 to 12 pounds per acre on medium sized soy beans. The dust should be applied on plants which are dry, as slight burning occurs when dust is applied on wet plants. A second application may be necessary about ten days after the first, if enough rain has fallen to wash the dust off the plants, if the field has another infestation from eggs hatching, or if larvae are migrating from neighboring fields. The caterpillars eat the dust on the plants and die. Some of them fall to the ground, while others hang to the plant. The dead larvae turn black and shrivel up. A rain that falls soon after dusting does not prevent the killing of larvae then present, but renders the dust less effective for the larvae which appear several days later.

2. A cultivation of soy beans soon after the larvae begin pupating has been found to kill a number of pupae.

3. When soy beans are planted for hay it is advisable to cut the crop as soon as these caterpillars appear, but where planted for seed production the soy beans should be dusted as soon as the first signs of larvae are noticed.

RELATIVE EFFECTS OF BORDEAUX MIXTURE AND OF HYDRATED LIME ON ARSENICAL SPRAYS IN THE CONTROL OF THE PECAN LEAF CASE-BEARER

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ABSTRACT

Bordeaux mixture and hydrated lime were tested to determine their relative effectiveness as correctives for arsenical injury to pecan foliage. Bordeaux mixture proved to be effective in preventing arsenical injury whereas hydrated lime did not, when the latter was used at the same strength as in the fungicide. When acid lead arsenate and Paris green were used separately in combination with Bordeaux mixture and at strengths at which they contained approximately the same quantity of metallic arsenic, the Paris green-Bordeaux mixture was the more effective against the pecan leaf case-bearer. Commercial calcium arsenate in combination with Bordeaux mixture, when the arsenical was used at a strength at which it contained more metallic arsenic than did either the acid lead arsenate or the Paris green as used in combination with Bordeaux mixture, gave insecticidal results nearly comparable to those of the Paris green-Bordeaux mixture combination. Commercial calcium arsenate in combination with Bordeaux mixture appeared much more effective in the control of the pecan leaf case-bearer than was acid lead arsenate in combination with Bordeaux mixture, when the same poundage of each arsenical was used. Furthermore, the cost of the calcium arsenate in the Bordeaux mixture was only about one-half that of the acid lead arsenate.

Severe foliage injury, amounting at times to almost complete defoliation, has occasionally resulted from the application of arsenical sprays to pecan foliage. Hydrated lime has been used successfully, in some instances, to eliminate foliage injury from acid lead arsenate ($PbHAsO_4$), the form generally used in spraying pecan trees for certain insects. However, many instances of severe injury to pecan foliage have occurred when the acid lead arsenate-hydrated lime combination has been used. During experimental work in 1927 and 1928, the writer observed that whenever Bordeaux mixture was combined with acid lead arsenate, no arsenical injury to pecan foliage occurred. In 1929, experiments were conducted to determine (1) the relative effects of Bordeaux mixture and of hydrated lime as correctives for arsenical injury, (2) the relative inhibiting action of Bordeaux mixture on the effectiveness of various arsenicals, and (3) whether an arsenical that is cheaper than acid lead arsenate could be employed effectively with this fungicide in the control of the pecan leaf case-bearer, *Acrobasis palliolella* Rag.

FIELD SPRAYING EXPERIMENTS IN 1929. To determine the relative effects of various combination sprays as to foliage injury and insecticidal efficiency under field conditions, a block of 260 pecan trees divided into plats of 20 trees each was used. The block consisted of the Schley variety, and the trees were 13 years of age and averaged from 25 to 35

feet in height. A careful examination of the trees showed that the infestation of the pecan leaf case-bearer was quite uniform throughout the block before the sprays were applied. The spraying was done with a large-capacity outfit equipped with a pump capable of discharging 25 gallons per minute. A pressure of 250 pounds was maintained during the tests. Two leads of hose were used, one operator spraying from the top of the spray tank with a large special pecan gun (with a disc aperture of ¼ inch) attached to 20 feet of ¾-inch hose, and the other operator spraying from the ground with an ordinary orchard spray gun (with a disc aperture of ⅛-inch) attached to 50 feet of ½-inch hose. The average quantity of liquid used per tree was 12 gallons.

In Tables 1 and 2 will be found data as to the experiments. In all the tests, except in plats 3 and 4, hydrated lime (analyzing approximately 73 per cent calcium oxide) was used in the same proportion. In plats 3 and 4 the Bordeaux mixture was more dilute and hence the quantities of lime in the sprays were smaller. In the combination sprays in plats 5 and 10 inclusive, Bordeaux mixture of the formula 3–5–50, employing pulverized copper sulphate and hydrated lime, was used. Plats 3 and 4 received sprays in which the quantities of Bordeaux mixture, and therefore of both copper sulphate and hydrated lime, in the combination were smaller. In plats 2 and 7 fish oil of "choice light pressed" grade, and in plat 8 calcium caseinate, were incorporated in the combinations used. This was done to ascertain whether or not spreaders would tend to promote foliage injury.

Acid lead arsenate and Paris green were used throughout the tests at strengths at which the quantities of metallic arsenic contained in them were approximately the same, whereas the commercial calcium arsenate was used at a strength at which it contained somewhat more metallic arsenic. As commercial calcium arsenate is considerably cheaper than acid lead arsenate or Paris green, it was assumed that if commercial calcium arsenate was used in the combination spray at the rate of 1 pound to 50 gallons and produced equal or better results than did the acid lead arsenate when used in the combination at the rate of 1 pound, or Paris green at the rate of one-half pound to 50 gallons, it would be immaterial whether the arsenic content of the arsenicals was the same or not. The commercial calcium arsenate used contained 45.15 per cent of arsenic oxide (As_2O_5) and 38.16 per cent of calcium oxide (CaO). Acid lead arsenate and Paris green are well standardized and generally contain about 30 per cent of arsenic oxide (As_2O_5) and 50 per cent of arsenious oxide (As_2O_3) respectively.

TABLE 1. ARSENICAL INJURY TO PECAN FOLIAGE CAUSED BY SPRAY COMBINATIONS, 1929

Plat No.	Combination spray and rate of application	Date of application	Date leaf injury first observed	Final leaf injury	Defoliation
1	Acid lead arsenate 1 lb., hydrated lime 5 lbs. to 50 gals. water	Aug. 5	Aug. 14	Severe	Partial
2	Acid lead arsenate 1 lb., hydrated lime 5 lbs. fish oil 1 pt. to 50 gals. water	Aug. 5	Aug. 14	Severe	Partial
3	Acid lead arsenate 1 lb. to 50 gals. ¾–1¼–50 Bordeaux mixture	Aug. 5	Aug. 30	Slight	None
4	Acid lead arsenate 1 lb. to 50 gals. 1½–2½–50 Bordeaux mixture	Aug. 5	———	None	None
5–6	Acid lead arsenate 1 lb. to 50 gals. 3–5–50 Bordeaux mixture	Aug. 5	———	None	None
7	Acid lead arsenate 1 lb., fish oil 1 pt. to 50 gals. 3–5–50 Bordeaux mixture	Aug. 6	———	None	None
8	Acid lead arsenate 1 lb., calcium caseinate ½ lb. to 50 gals. 3–5–50 Bordeaux mixture	Aug. 6	———	None	None
9–10	Commercial calcium arsenate 1 lb. to 50 gals. 3–5–50 Bordeaux mixture	Aug. 5	———	None	None
11	Paris green ½ lb. to 50 gals. 3–5–50 Bordeaux mixture	Aug. 6	———	None	None
12	CHECK (1)	———	———	None	None
13	CHECK (2)	———	———	None	None

SPRAY INJURY. The results as recorded in Table 1 show that the acid lead arsenate-hydrated lime and the acid lead arsenate-fish oil-hydrated lime combinations (plats 1 and 2) caused considerable burning to pecan foliage and partial defoliation. A little more injury was noted in plat 2, where fish oil was used in the combination spray, than in plat 1. The injury to the foliage was first observed nine days after these combinations were applied. From August 5 and 6, when the applications were made, to the end of the month, frequent showers and occasional heavy dews occurred. In plat 3 where acid lead arsenate in combination with ¾–1¼–50 Bordeaux mixture was applied, slight foliage injury but no defoliation occurred. No injury resulted when acid lead arsenate was

used in combination with 1½–2½–50 Bordeaux mixture, as in plat 4. In plats 5, 6, 9, 10, and 11, where 3–5–50 Bordeaux mixture was used in combination with acid lead arsenate, commercial calcium arsenate, and Paris green, no foliage injury or defoliation occurred. In plats 7 and 8 the fish oil and calcium caseinate when added to Bordeaux mixture-arsenical combinations did not affect the combinations in such a way as to cause arsenical injury.

The results show that Bordeaux mixture 3–5–50 was far more effective as a corrective for arsenical injury to pecan foliage than hydrated lime used at the same strength as in the Bordeaux mixture.

PROBABLE REASONS FOR THE ACTION OF BORDEAUX MIXTURE IN PREVENTING ARSENICAL INJURY TO PECAN FOLIAGE. Not much investigational work on the chemistry of Bordeaux mixture-arsenical combinations, to determine why Bordeaux mixture prevents arsenical injury to foliage, appears to have been carried out. The probable reason for this is that if the action is chemical a more definite knowledge of the chemistry of Bordeaux mixture than is at present available would be required. According to Pickering (*1*) the copper salt present in Bordeaux mixture is a double basic sulphate of copper and calcium to which he has given the formula $(CuO)_{10}SO_3\ (CaO)_4SO_3$. When arsenicals are combined with Bordeaux mixture, this insoluble double basic sulphate of copper and calcium may act in one of two ways in preventing arsenical injury, (1) by absorbing soluble arsenic or (2) by combining chemically with it.

Fields and Elliott (*2*) reported that the quantity of arsenic in solutions decanted from different combinations of Bordeaux mixture with either acid lead arsenate or neutral lead arsenate is very small even after the solutions have stood two weeks.

Cook and McIndoo (*3*), employing a dried precipitate of Bordeaux mixture in combination with acid lead arsenate, calcium arsenate, sodium arsenate, and Paris green, found that the quantity of water-soluble arsenic in the combination was less than that in the arsenicals alone.

Goodwin and Martin (*4*) reported on results of experiments with glass wool and found that the addition of copper sulphate to lead arsenate-calcium hydroxide mixtures accomplished the removal or prevented the formation of soluble arsenic. They also stated that the addition of copper sulphate to dicalcium arsenate, basic calcium arsenate, or commercial calcium arsenate in combination with calcium hydroxide caused an enormous reduction in the soluble arsenic formed. When hydrated

lime alone was added to these arsenicals arsenic oxide (As_2O_5) in much larger quantities was produced in solution. They did not investigate the causes for the reduction in the quantity of arsenic in solution or attribute them to the action of the Bordeaux mixture. However, they said: "It may be that the action is more physical than chemical, and that the deposition of the basic copper compounds upon the particles of the arsenical may form a protective coating by which, in the case of the basic calcium arsenates, hydrolysis is retarded, or, in the case of the lead arsenate, the interaction with the lime is prevented." They reported, further, that an "equal lime" Bordeaux mixture containing an equivalent quantity of calcium hydroxide proved far more effective in reducing arsenical injury than the calcium hydroxide alone.

Sanders and Kelsall (*5*) reported that when calcium arsenate is used alone it may under some conditions burn foliage, but when used in combination sprays with Bordeaux mixture it is as safe as any known arsenical.

METHOD USED IN MAKING COUNTS FOR DETERMINING PERCENTAGES OF EFFECTIVENESS FOR THE VARIOUS COMBINATIONS TESTED AGAINST THE PECAN LEAF CASE-BEARER. In order to determine the effectiveness of the arsenicals in combinations tested against the pecan leaf case-bearer, it was found necessary to determine, after the pecan trees had lost their foliage in the fall, percentages of infested buds and hibernacula which had actually been formed on the current season's growth. The larvae of the pecan leaf case-bearer feed very sparingly over a period of several months during the summer and early fall. They do not mature before going into hibernation and attain an approximate average length of only 1/16 inch. After pecan foliage is sprayed it may take from a day to several weeks for individual larvae to reach the poison on the surface of the foliage under field conditions. Hence, it was found impossible to determine at just what period accurate counts could be made by examining the larvae on the foliage after applications, to determine the percentages of effectiveness for the various combinations. In addition, as the very tiny larvae feed from small tightly-woven spiral cases, it was found very difficult to dissect them, in order to determine effectively the values of the sprays, without injuring the larvae. Consequently counts were made of the infested buds, and of the hibernacula which formed on them, to arrive at percentages of control.

RELATIVE EFFECTIVENESS OF ARSENICALS WHEN COMBINED WITH BORDEAUX MIXTURE AND HYDRATED LIME AGAINST THE PECAN LEAF CASE-BEARER. Sanders and Brittain (*6*) found that fungicides inhibit

the action of arsenical sprays. Cook and McIndoo (*3*) reported that when lime or Bordeaux mixture was combined with arsenicals the toxicity of the arsenicals was reduced. They found that leaves sprayed with arsenicals combined with Bordeaux mixture usually contained less arsenic than those similarly sprayed with the arsenicals alone, and that the toxic effect was greater in tests with honeybees fed honey containing arsenicals alone than in tests in which bees ate honey containing arsenicals combined with lime or Bordeaux mixture. They found that the toxicity varied considerably depending on the species of insect, and that the addition of Bordeaux mixture to acid lead arsenate, to calcium arsenate, to sodium arsenate, and to zinc arsenite reduced the toxicities of these arsenicals to silkworms, webworms, and honeybees but reduced the toxicity to tent caterpillars little if any. Their analytical data show that the addition of hydrated lime to the arsenicals against all insects used reduced the toxic value of the arsenicals slightly more than did the addition of Bordeaux mixture.

By reference to Table 1 it will be seen that defoliation occurred in plats 1 and 2. Owing to the fact that considerable premature defoliation occurred in these plats where acid lead arsenate-hydrated lime and acid lead arsenate-fish oil-hydrated lime combinations were used before the larvae commenced to go into hibernation, the values secured (Table 2) can not be compared with those secured in the plats where the foliage was not impaired in any way by spray applications. In comparing the percentages of infested buds and of hibernacula which formed on the buds, better values were secured in plats 9 and 10, where commercial calcium arsenate-Bordeaux mixture was used, than in plats 5 and 6, which received acid lead arsenate-Bordeaux mixture, or in plat 7, which received acid lead arsenate-fish oil-Bordeaux mixture. That the commercial calcium arsenate-Bordeaux mixture was the more effective combination might be ascribed to the fact that when acid lead arsenate is combined with Bordeaux mixture, the excess lime reacts with the acid lead arsenate, producing basic calcium arsenate ($Ca_5(AsO_4)_3OH$ and basic lead arsenate ($Pb_4PbOH(AsO_4)_3$, the latter compound being much less toxic to insects generally than acid lead arsenate or calcium arsenate. It should also be considered that although the acid lead arsenate and commercial calcium arsenate were used on an equal poundage basis, the latter arsenical contained more metallic arsenic. On the other hand, commercial calcium arsenate, which contains an excess of lime, is not broken up or altered in any way by the action of Bordeaux mixture. In plat 11 the Paris green-Bordeaux mixture combination gave a value slightly better than where commercial calcium arsenate-Bordeaux mixture was used, as in plats 9 and 10.

TABLE 2. RELATIVE EFFECTIVENESS OF ARSENICALS WHEN COMBINED WITH BORDEAUX MIXTURE AND HYDRATED LIME AGAINST THE PECAN LEAF CASE-BEARER 1929

Plat No.	Combination spray and rate of application	Date of application	Number of buds examined	Total number of infested buds	Total number of hibernacula formed on buds	Per cent infested buds	Number of hibernacula per 100 buds
1	Acid lead arsenate 1 lb., hydrated lime 5 lbs., to 50 gals. water	Aug. 5	4,125	13	16	0.31	0.38
2	Acid lead arsenate 1 lb., hydrated lime 5 lbs., fish oil 1 pt., to 50 gals. water	Aug. 5	4,066	37	53	0.90	1.30
3	Acid lead arsenate 1 lb. to 50 gals. ¾–1¼–50 Bordeaux mixture	Aug. 5	—	—	—	—	—
4	Acid lead arsenate 1 lb. to 50 gals. 1½–2½–50 Bordeaux mixture	Aug. 5	—	—	—	—	—
5	Acid lead arsenate 1 lb. to 50 gals. 3–5–50 Bordeaux mixture	Aug. 5	4,059	166	255	4.08	6.27
6	Acid lead arsenate 1 lb. to 50 gals. 3–5–50 Bordeaux mixture	Aug. 5	4,149	204	318	4.91	7.66
7	Acid lead arsenate 1 lb., fish oil 1 pt., to 50 gals. 3–5–50 Bordeaux mixture	Aug. 6	4,192	98	140	2.33	3.33
8	Acid lead arsenate 1 lb., calcium caseinate ½ lb., to 50 gals. 3–5–50 Bordeaux mixture	Aug. 6	—	—	—	—	—
9	Commercial calcium arsenate 1 lb. to 50 gals. 3–5–50 Bordeaux mixture	Aug. 5	4,000	20	25	0.50	0.62
10	Commercial calcium arsenate 1 lb. to 50 gals. 3–5–50 Bordeaux mixture	Aug. 5	3,979	49	58	1.23	1.45
11	Paris green ½ lb. to 50 gals. 3–5–50 Bordeaux mixture	Aug. 6	4,130	20	24	0.48	0.58
12	CHECK (1)	—	4,221	808	1,446	19.14	34.25
13	CHECK (2)	—	4,535	842	1,485	18.56	32.74

The differences between the percentages of hibernacula formed on the buds where commercial calcium arsenate or Paris green was used, and where, as in the checks, no sprays were applied, are significant and indicate that the Bordeaux mixture did not inhibit the action of these arsenicals to any appreciable extent if at all. In the case of acid lead arsenate the differences in percentages are more pronounced, owing possibly to the chemical changes which occurred when acid lead arsenate was combined with Bordeaux mixture as previously described. In Plat 7, where fish oil was used in combination with acid lead arsenate and Bordeaux mixture, the fish oil increased the effectiveness of the combination, as can be seen by a comparison with the results in Plats 5 and 6, although the difference in effectiveness was not sufficient to warrant incorporating fish oil in combinations where Bordeaux mixture is used.

SUMMARY.

Acid lead arsenate-hydrated lime and acid lead arsenate-fish oil-hydrated lime mixtures, under the conditions of the experiments, caused arsenical injury to pecan foliage and partial defoliation.

Acid lead arsenate in combination with ¾–1¼–50 Bordeaux mixture caused slight foliage injury and no defoliation, and the same arsenical when used with 1½–2½–50 Bordeaux mixture did not cause any foliage injury or defoliation.

Acid lead arsenate, commercial calcium arsenate, and Paris green, when combined with Bordeaux mixture 3–5–50, did not cause any foliage injury or defoliation.

Bordeaux mixture is a much better corrective for arsenical injury to pecan foliage than hydrated lime used at the same strength as in the fungicide.

No material advantage is gained in incorporating fish oil or calcium caseinate in combinations of Bordeaux mixture and arsenicals, as Bordeaux mixture, being colloidal in character, is a very good sticker and spreader for arsenicals.

A comparison of the percentages of hibernacula of the pecan leaf case-bearer formed on the buds of pecan trees sprayed with commercial calcium arsenate or Paris green combined with Bordeaux mixture, with the percentages formed on trees in the untreated plats indicates clearly that Bordeaux mixture did not inhibit the action of the arsenicals to any appreciable degree if at all. The results secured where acid lead arsenate in combination with Bordeaux mixture was used are not so significant and indicate the probability that chemical changes occurred in the combination which influenced the results.

Commercial calcium arsenate in Bordeaux mixture, when the arsenical was used on the same poundage basis as acid lead arsenate in Bordeaux mixture, was considerably the more effective insecticide against the pecan leaf case-bearer.

Paris green in Bordeaux mixture, when used at a strength at which it contained approximately the same quantity of metallic arsenic as did the acid lead arsenate used in Bordeaux mixture, was more effective than the latter, and slightly more effective as compared with commercial calcium arsenate in Bordeaux mixture when the commercial calcium arsenate was used at a strength at which it contained more metallic arsenic.

Commercial calcium arsenate may be used in Bordeaux mixture at the same poundage as acid lead arsenate in Bordeaux mixture, with greater effectiveness, in the control of the pecan leaf case-bearer and with a saving in the cost of the arsenical of about one-half.

Literature Cited

1. Pickering, W. The chemistry of Bordeaux mixture. Jour. Chem. Soc. London, Vol. XCI, 1907, pp. 1988 and 2001.
2. Fields, W. S., and Elliott, J. A. Making Bordeaux mixture and some other spraying problems. Ark. Agr. Exp. Sta. Bul. 172 (1920), 12 p.
3. Cook, F. E. and McIndoo, N. E. Chemical, Physical and Insecticidal Properties of Arsenicals. U. S. Dept. Agr. Bul. 1147 (1923), 57 p
4. Goodwin, W., and Martin, H. Bordeaux mixture combined with arsenical sprays. *In* Jour. Agr. Science (1928), Vol. 18, part 3, pp. 460–477.
5. Sanders, G. E., and Kelsall, A. Some miscellaneous observations on the origin and present use of some insecticides and fungicides. *In* Proc. Ent. Soc. Nova Scotia for 1918, No. 4, pp. 69–73.
6. Sanders, G. E., and Brittain, W. H. The toxic value of some poisons alone and in combination with fungicides, on a few species of biting insects. *In* Proc. Ent. Soc. Nova Scotia for 1916, No. 2, pp. 55–64.

RESULTS OF SPRAYING AND DUSTING EXPERIMENTS ON LARGE BLOCKS OF PEACH TREES FOR THE CONTROL OF THE CURCULIO

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Abstract

Blocks of peach trees 26 by 26 rows each were used for these experiments to determine the comparative effectiveness of spraying and dusting and to test the value of the "petal-fall" application. Lead arsenate applied as a spray was found to be more effective against the curculio (*Conotrachelus nenuphar* Herbst) attacking peaches than the same insecticide applied in a dust mixture. The petal-fall spray, applied when 50 to 75 per cent of the petals had fallen, was shown to be an important part of the spray schedule.

For more than ten years the writer has been investigating the comparative effectiveness of lead arsenate in sprays and in dust mixtures for the control of the curculio, *Conotrachelus nenuphar* Herbst, attacking peaches. The experiments were usually conducted on plats of approximately 200 trees each, and under conditions of moderate curculio infestations there appeared to be little difference in the control from the insecticide applied by the two methods. Therefore, the Bureau has been issuing both a spraying schedule and a dusting schedule for the control of the curculio on peach trees, leaving it to the grower to choose the method of applying the insecticide.

During years when a very heavy curculio infestation occurred, our results showed that the lead arsenate applied as a spray gave better control of the curculio than the same insecticide in a dust mixture. On account of the heavy curculio population going into hibernation last fall as a result of the leaving of a considerable quantity of wormy peaches in the orchards when the peach markets collapsed during the season of 1928, and owing to the following mild winter, we predicted an unusually heavy curculio infestation in 1929. Throughout the entire Southern peach-growing region it proved to be perhaps the heaviest infestation on record, and the second heaviest ever to have occurred in the Georgia peach belt. That prediction caused us to decide to test durin season of 1929, the comparative effectiveness of the two methods of applying lead arsenate, on blocks of peach trees much larger than we had ever used before. Since the effectiveness of the "petal-fall" application for curculio control is still not fully appreciated, we decided to test also the value of that application on a large block of trees.

Orchard Used for Experiments in 1929. A six-year-old Elberta orchard near Fort Valley, in the heart of the Georgia peach belt, was used for the experiments. It contained the heaviest curculio infestation of any orchard in the district with which we were familiar. As a result of the lack of control measures, a heavy curculio population was built up in this orchard by the season of 1928. The orchard bore a heavy crop that year, but on account of the wormy and rotten condition of the fruit and the collapse of the peach market, none of the fruit was picked. It was allowed to fall to the ground, and it was not afterwards removed from under the trees. Jarring trees in this orchard when the curculio beetles began leaving hibernation in the spring of 1929, to ascertain the extent of the infestation, showed as high as 25 curculios per tree. The experiments were therefore conducted in an orchard in which the curculio infestation was perhaps as heavy as it ever occurs.

SCHEDULES TESTED AND HISTORY OF APPLICATIONS. The orchard contained 1,797 vigorous trees in a good state of productivity. It was bordered on three sides by cultivated fields and on the fourth side by an orchard. The blocks were headed into this adjoining orchard so that no block was subjected to more sources of curculio infestation than another. There were no wooded areas or uncultivated fields near by to subject any part of the orchard to such favored places of hibernation. It was an ideal place to test the effectiveness of several schedules of arsenical treatments.

The orchard was divided into three blocks of 26 by 26 rows each. Block one contained 608 trees, block two contained 626 trees, and block three contained 563 trees. The following outline gives the schedules that were tested on these blocks.

OUTLINE OF EXPERIMENTS IN SPRAYING AND DUSTING PEACH TREES, FOR THE SEASON OF 1929, FORT VALLEY, GA.

		Time of Application			
Block No.	Treated with	As petals fall	When calyces are shedding	Two weeks after shedding of calyces	Four weeks before harvest
I.....	Dust	0–5–95	0–5–95	80–5–15	80–5–15
II.....	Spray	A.L.L.	A.L.L.	A.L.L.+ fungicide	A.L.L.+ fungicide
III.....	Spray	———	A.L.L.	A.L.L.+ fungicide	A.L.L.+ fungicide

0–5–95 = Lead Arsenate, 5 per cent; hydrated lime, 95 per cent.
80–5–15 = Sulphur, 80 per cent; lead arsenate, 5 per cent; hydrated lime, 15 per cent.
A.L. = Lead arsenate powder, 1 pound to 50 gallons of spray.
L. = Milk of lime, made from 4 pounds of hydrated lime per 50 gallons of spray.

Each application was given to the three blocks on the same day. The dusting was done about sun-up in the morning, which is usually the calmest time of the day, and most of the spray was applied when the wind was very light. H. S. Swingle supervised all the dusting and spraying, and placed the ingredients in the machines. He saw to it that each tree received a thorough application of spray or dust at each time of treatment, and is due credit for assisting with these experiments until the beginning of harvest. The dusts were applied with a dusting machine driven by a 3½ H. P. engine and the sprays were applied at a pressure of 250 pounds with a sprayer driven by a 3 H. P. engine.

At the first application Block No. I received 160 pounds of dust in one hour and twenty minutes, and Block No. II received 300 gallons of spray in two hours and one minute. At the second application, Block No. I received 170 pounds of dust in one hour and twenty minutes, Block No. II received 475 gallons of spray in three hours and forty

minutes, and Block No. III received 400 gallons of spray in two hours and fifty-five minutes. At the third application Block I received 300 pounds of dust in one hour and thirty minutes, Block II received 570 gallons of spray in four hours and five minutes, and Block III received 450 gallons of spray in three hours and twenty-five minutes. At the fourth application Block I received 285 pounds of dust in one hour and ten minutes, Block II received 408 gallons of spray in two hours and forty-five minutes, and Block III received 352 gallons of spray in two hours and twenty minutes.

RESULTS. Ten trees were selected in the center of each block as record trees. As there were 26 rows between the record trees of each block, there was no danger of a drift of spray or dust from an adjoining block to the record trees. All of the drops that fell from the record trees were collected and cut open to determine the percentage infested by the curculio, as the adults that develop from infested drops deposit the eggs for the second brood of larvae which appear in the peaches at harvest. At harvest all of the fruit was taken from the record trees and cut open to ascertain the exact percentage of the matured fruit damaged by the curculio.

Table 1 gives the results obtained from the examination of drops from the record trees in each block.

TABLE 1. NUMBER OF PEACH DROPS, AND PERCENTAGE OF THEM INFESTED BY CURCULIO; SPRAYING AND DUSTING EXPERIMENTS, FORT VALLEY, GA., 1929

Block	Treatment	Total number of drops examined	Total percentage of drops infested by the curculio
I	Dust, full schedule	8,844	39.6
II	Liquid spray, full schedule	9,514	28.6
III	Liquid spray, petal-fall application omitted	8,940	39.4

There was 38.5 per cent more wormy drops in the dusted block than in the sprayed block. In the block where the first spray was omitted there was 37.8 per cent more wormy drops than in the sprayed block that received the early spray for the curculio. A reduction of the amount of curculio infestation in the drops correspondingly reduces the size of the second brood of larvae at harvest.

Table 2 presents the results obtained from the examination of the fruit from the record trees of each block at harvest time.

The dusted block had 30.2 per cent more wormy fruit than the sprayed block. The sprayed block on which the first application was omitted had 30.0 per cent more wormy fruit than the sprayed block on which the usual four applications were used. The results on brown rot were taken to show the interrelation between curculio injury and brown rot in-

TABLE 2. SUMMARY OF RESULTS OF EXAMINATION OF PEACHES AT HARVEST; SPRAYING AND DUSTING EXPERIMENTS, FORT VALLEY, GA., 1929

			Percentage of total fruit having—						
Block	Treatment	Total No. fruit	Curculio larvae	Brown rot	Curculio larvae only	Brown rot only	Curculio larvae and brown rot	Brown rot infection at curculio puncture	Percentage of total fruit found to be sound
I	Dust, full schedule.....	1,017	56.0	33.3	36.8	14.1	7.9	11.3	30.0
II	Liquid spray, full schedule...........	1,799	43.0	11.7	38.9	7.6	0.7	3.4	49.4
III	Liquid spray, petal-fall application omitted..	1,404	55.9	22.4	43.7	10.2	4.1	8.1	33.9

fection. The dusted block had 184.6 per cent more rotten fruit than the block that received the spray. The infection on 11.3 per cent of the rotten fruit was at curculio punctures. While the two sprayed blocks were given the same fungicidal treatments, there was 91.5 per cent more rotten fruit in Block III where the first curculio spray was omitted than in Block II that received the early spray. 8.1 per cent of the brown rot infections in Block III were at curculio punctures. Of the rotten fruit in the block that received four applications of spray, only 3.4 per cent was at curculio punctures.

The percentage of total fruit found to be sound is not high; however, in interpreting the results of these experiments, one must first consider the conditions that existed in this orchard when the work was started and the very severe test to which all treatments were put. The Elberta peaches from this orchard were better than those produced in any of the other orchards of that locality.

Conclusions

1. Lead arsenate applied as a spray is more effective against the curculio attacking peaches than the same insecticide applied in a dust mixture.
2. The petal-fall spray, applied when 50 to 75 per cent of the petals have fallen, has been shown to be an important part of the spray schedule.

THE ONION THRIPS ON SEEDLING COTTON, WITH A SEASON'S RECORD OF PARTHENOGENETIC DEVELOPMENT*

By C. O. Eddy and W. H. Clarke,[1] *S. C. Experiment Station*

Abstract

Infestations of the onion thrips, *Thrips tabaci* Lind., caused seedling cotton plants to grow slowly and assume a malformed condition. Buds were rarely blasted. Lateral growth sometimes resulted. Unfolding leaves had holes, marginal erosions, raised thin areas, and a crinkly surface. Using approximate figures, the average unmated female lived 14 days and laid 14 eggs in a period of eight days. Individuals developed in 14 days, nearly five days being spent in the egg, between two and three in each of the two larval instars, one and one-half in the propupa, and three in the pupa. In July a generation followed the previous one as closely as 15 days, the period lengthening to 26 days in August.

*Technical Contribution No. 1 (New Series) from the South Carolina Agricultural Experiment Station.

[1]Resigned January 15, 1930. Now with Georgia State Board of Entomology.

During the last several years when seedling cotton plants were growing slowly and abnormally in South Carolina, several species of thrips have been present in the unfolding buds and on the leaves. This fact has also been observed by other workers in Louisiana, Texas, Georgia, and perhaps in other states, as shown in the cooperative reports of cotton insect activity issued from the Delta Laboratory of the United States Bureau of Entomology at Tallulah, Louisiana. One of the most abundant species of thrips in South Carolina has been the onion thrips, *Thrips tabaci* Lind.[2]

OBJECT. In insectary tests during 1929 experiments were conducted to determine the type of injury onion thrips caused to seedling cotton plants. In further studies data were collected on the life history of the insect during five generations of parthenogenetic development from May 26 to September 25 of that season.

INJURY. A successful method used in determining the type of injury caused by the onion thrips involved the use of soil tables in which seedling plants were grown. Infestations of the thrips on the seedling plants were roughly controlled. Different degrees of infestations were established in various series of tests, the number of insects per plant varying from one to ten.

Plate 23 shows two seedling plants which had been attacked by the onion thrips compared with one which was uninfested by the insect. It may be seen from a study of the illustrations that growth proceeded terminally but more slowly and in a very much malformed condition. Buds were rarely blasted. It may also be noted that lateral growth was started from the buds in the axils of the cotyledon leaves in certain cases. This condition occurred more commonly in plants which were infested with thrips than in normal plants, but much less frequently than in plants attacked by the cotton flea hopper, *Psallus seriatus* Reut. Almost no growth was apparent on certain infested plants. Plants in that condition were frequently retarded as much as two weeks or more.

A close observation of leaves that have unfolded from infested buds shows holes, marginal erosions, raised thin areas, and a crinkly surface. The degree of injury of this kind increases with greater infestations.

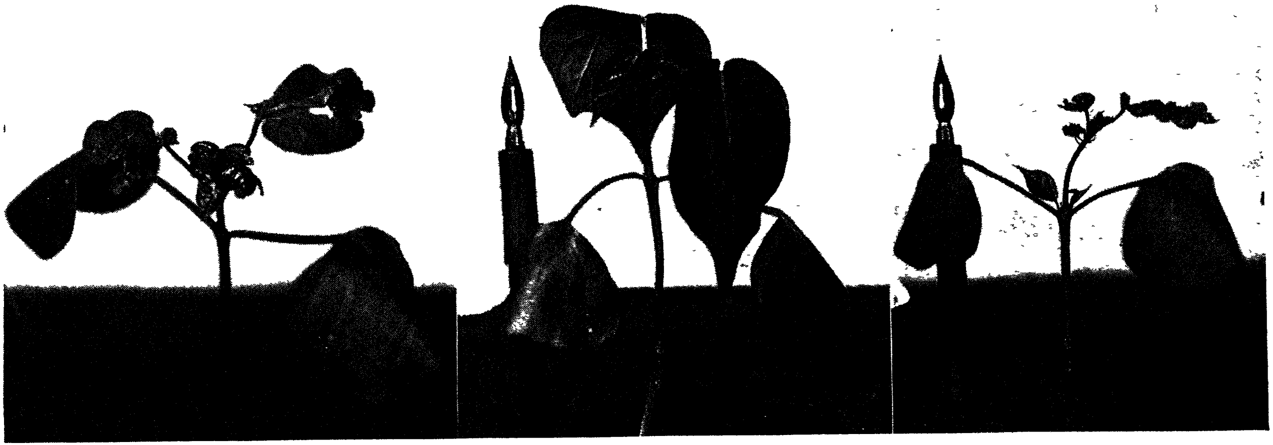
A discussion of the removal of tissue from the lower surface of unfolded leaves is omitted as this factor seems to have very much less effect on seedling cotton growth than does the destruction of tissues in the buds.

[2]Determinations by Professor J. R. Watson of the Florida Experiment Station and by Mr. A. C. Morgan of the Bureau of Entomology.

TABLE 1. RECORD OF UNMATED FEMALES—1929

Gen.	No. of cases	Pre-oviposition period			Oviposition period			Post-oviposition period			Total life of female			Eggs per female per gen.	Max. eggs by one female	Min. eggs by one female	Eggs per day by one female			Period during which females lived	
		Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.				Max.	Min.	Av.		
1	5	7	2	5.4	14	1	5.8	6	1	2.6	22	5	13.0	10.8	28	1	10	0	1.86	6/10	7/2
2	5	4	2	3.0	14	3	8.0	4	0	1.6	18	8	12.6	22.8	46	5	14	0	2.85	6/29	7/19
3	10	6	2	3.6	24	1	11.9	5	0	2.4	28	7	16.9	20.2	46	3	8	0	1.42	7/15	8/28
4	13	6	1	3.69	26	1	7.77	6	1	3.38	28	4	14.62	11.16	33	1	6	0	1.44	7/31	9/20
5	4	5	3	3.75	12	1	7.00	4	2	2.75	17	9	12.5	5.5	8	2	4	0	0.79	8/23	9/25
All Gen.	37	7	1	3.81	26	1	8.57	6	0	2.7	28	4	14.51	14.51	46	1	14	0	1.69		

Plate 23



Two cotton seedling plants injured by the onion thrips. Check in the center.

TABLE 2. SUMMARY OF DEVELOPMENT BY GENERATIONS MAY 26 TO AUGUST 23

Gen.	Cases	Date first eggs	Incubation period	First instar	Second instar	Propupa	Pupa	Date last adult emerges	Larval and pupal dev.	Incubation and dev.	Av. mean temp.
1	9	5/26	5.2	3.0	2.6	1.3	3.2	6/28	10.2	15.3	75
2	15	6/16	4.5	2.7	2.5	1.7	2.6	7/15	9.6	14.2	79
3	47	7/3	4.7	2.4	2.7	1.4	2.9	8/2	9.4	14.1	78
4	51	7/18	4.5	2.4	2.8	1.2	2.7	9/9	9.2	13.7	77
5	48	8/9	4.4	2.2	3.2	1.3	3.2	Closed 9/24	9.9	14.4	76
6	2	8/31	5.0	1.5	3.5	1.5	4.5	Closed 9/23	11.0	16.0	74
All Gen.	172	5/26	4.72	2.33	2.88	1.4	3.18	Closed 9/24	9.88	14.62	76.5

PARTHENOGENETIC LIFE HISTORY. The life history studies with the onion thrips were carried on by the use of one-gram homeopathic vials, ¾ by 6 inch test tubes, absorbent cotton, insect-free seedling cotton leaves, and water. The virgin females were confined separately in the homeopathic vials and a section of a fresh seedling cotton leaf placed with each of them every 24 hours. The used sections of leaves were removed from the vials, wrapped individually in moist absorbent cotton, and each placed in a sterile test tube. The open ends of both vials and test tubes were closed with absorbent cotton plugs. The leaves in the test tubes were removed daily and observed under a low power binocular microscope for emerged larvae. When a larva was found, it was removed from the leaf with a small brush and transferred to a fresh leaf in a small homeopathic vial where development was observed. Fresh leaves were supplied to all larvae when needed. Vials and test tubes containing the thrips were inserted slightly in the soil of soil tables in an outdoor insectary.

TABLE 3. SUCCESSION OF GENERATIONS STUDIED

Gen.	First eggs laid	Last adult died	Total days
X	—	6/29	—
1	—	7/2	—
2	6/11	7/19	38
Interval of 22 days			
3	7/3	8/28	56
Interval of 15 days			
4	7/18	9/20	64
Interval of 16 days			
5	8/3	9/25	—
Interval of 26 days			
6	8/29	9/25	—

ACTIVITY OF FEMALES. Adult female onion thrips were collected in the field over a period of about two weeks during early May 1929.

These individuals were placed on test as described above. Records reported do not include the activities of these females, but begin with the incubation of the eggs produced by them, these later forms constituting what we have designated as the first generation.

The following data are based on the records secured from 37 virgin females representing five generations between June 12 and September 25. The data are shown in summary form in Table 1. As the eggs were deposited in the plant tissue, the number laid could not be easily nor accurately determined. A record of the number of larvae emerging from the leaf tissue is substituted for the number of eggs laid.

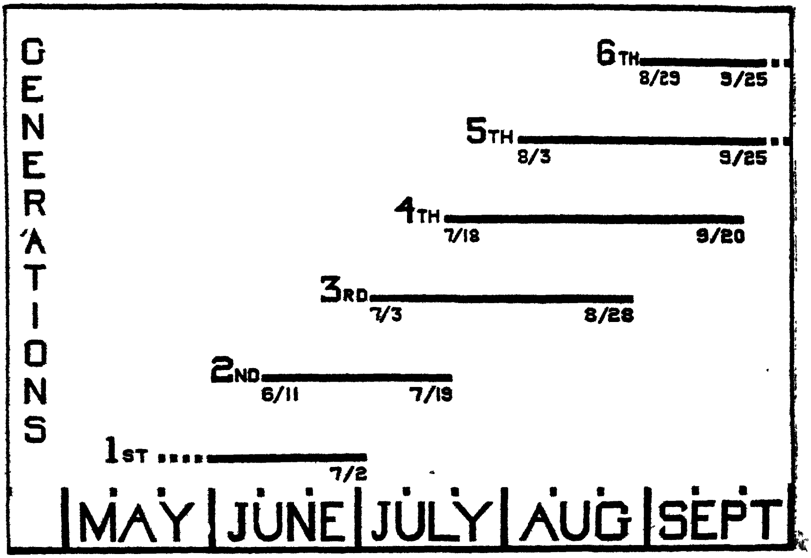


Figure 60.—Succession of generations of onion thrips reared on cotton.

Development. The data of development are presented under the form closely approximating that of complete metamorphosis: i. e., egg, larva, pupa, and adult, there being with the Thysanoptera two feeding larval instars and a non-feeding propupal and a pupal stage. The data is presented in Table 2 without discussion.

A study of the succession of generations is presented in Table 3 and graphically illustrated in Figure 60. It is interesting to note that generations followed as closely as 15 days in July, the period lengthening to 26 days in August.

ERAX INTERRUPTUS MACQ. AS A PREDATOR

By B. A. Osterberger, *Louisiana Experiment Station*[1]

Abstract

During the fall and winter of 1928 and 1929 there were found in the soil in fields of sugarcane and other field crops many larvae of *Erax interruptus*. Laboratory experiments indicate that the larvae feed very readily on white grubs. Pupation began the first week in May and lasted until the first week in June, requiring from 20 to 26 days for the transformation to adult. *Erax interruptus* is of economic importance in sugarcane areas as a predator attacking white grubs of *Euetheola rugiceps*, the sugarcane beetle.

Examinations of freshly plowed soil during the fall and winter of 1928 yielded many slender, creamy white larvae, legless and with body tapering towards each end. These larvae when full grown were from 25 to 30 mm in length, and had tiny brown heads partly covered by the thorax, and with prominent mandibles. Some of these larvae were sent to Dr. C. P. Alexander and Mr. Stanley W. Bromley. The species was not definitely fixed as *Erax interruptus* Macquart until adults were bred.

In these observations were also found many white grubs; so working on the assumption that these were the natural food of the species, fourteen of the larvae were placed in sterilized salve boxes with sterilized soil, and in each box was placed a white grub. Daily observations were made and fresh white grubs were added as needed until the adults emerged. Considerable difficulty was experienced from molds and mites introduced with fresh white grubs. Several larvae were killed. This difficulty was finally overcome by frequent change of sterilized boxes and soil and by dipping the white grubs in a very weak formaldehyde solution and by washing in water.

Table 1. Life History and Feeding Activities of *Erax interruptus*

Larvae No.	Date Collected	Grubs Consumed	Larvae Died	Larvae Pupated	Adult Emerged
1.....	Dec. 1, '28	1	Apr. 12, '29		
2.....	" " "	2		May 17, '29	June 6, '29
3.....	" " "	2	Feb. 5, '29		
4.....	" " "	1	May 17, '29		
5.....	" " "	0	Mar. 22, '29		
6.....	" " "	2		May 13, '29	June 3, '29
7.....	" " "	1	Feb. 1, '29		
8.....	" " "	1	Jan. 19, '29		
9.....	" " "	0	Jan. 11, '29		
10.....	" " "	1	Mar. 5, '29		
11.....	" " "	1		May 8, '29	June 3, '29
12.....	" " "	1	Apr. 1, '29		
13.....	" " "	0	Apr. 1, '29		
14.....	" " "	0		May 20, '29	June 10, '29

[1]Published by permission of the Director, Louisiana Experiment Station.

The feeding (Pl. 24, fig. 1) was accomplished by the larva attaching itself to the white grûb in a tender, unprotected region just back of the head. There it remained attached until all the body fluids were sapped, leaving the white grub very limp. Daily records were kept of the number of white grubs used in feeding the *Erax* larvae:

Erax interruptus hibernates in the soil in the larval stage. Under laboratory conditions pupation was begun after the first week in May, and adults emerged the first week in June. The length of pupal stage varied from 20 to 26 days.

The pupa (Pl. 24, fig. 1) was yellowish brown, from 15 to 20 mm in length, heavily armed with spines and with prominent spiracles on most of the abdominal segments. Many empty pupal cases have been found after rains, especially in the more sandy river soils.

The adult (Pl. 24, figs. 3, 4) has a pair of large eyes, and the head is mounted on a narrow neck which enables the insect to see in all directions. The proboscis is long, sharp and stiffened by a heavy coat of chitin. The body is from 20 to 25 mm in length, slender, but with strong long legs. The wings are sufficiently strong to enable swift flight and also the carrying of its prey, which may be larger than the fly itself. The abdomen has traces of short gray hair, and the head and legs are covered with long gray hairs.

In view of the feeding habits of the larva and its wide distribution and abundance, *Erax interruptus* is one of the most beneficial Asilidae. Its value as a predator in the adult stage is recognized, but little has been known about its food habits in the larval stage.

Titus in 1905 listed a species of *Erax* as a predator of the white grub of the sugarcane beetle (*Euetheola rugiceps*). It is hoped that future work will point out a way to make *Erax* more effective as a natural check on the activities of this and other similar crop pests.

The writer wishes to express thanks to Dr. C. P. Alexander for his interest and suggestions and to Mr. Stanley W. Bromley for determining specimens, and for information on habits and distribution.

LITERATURE

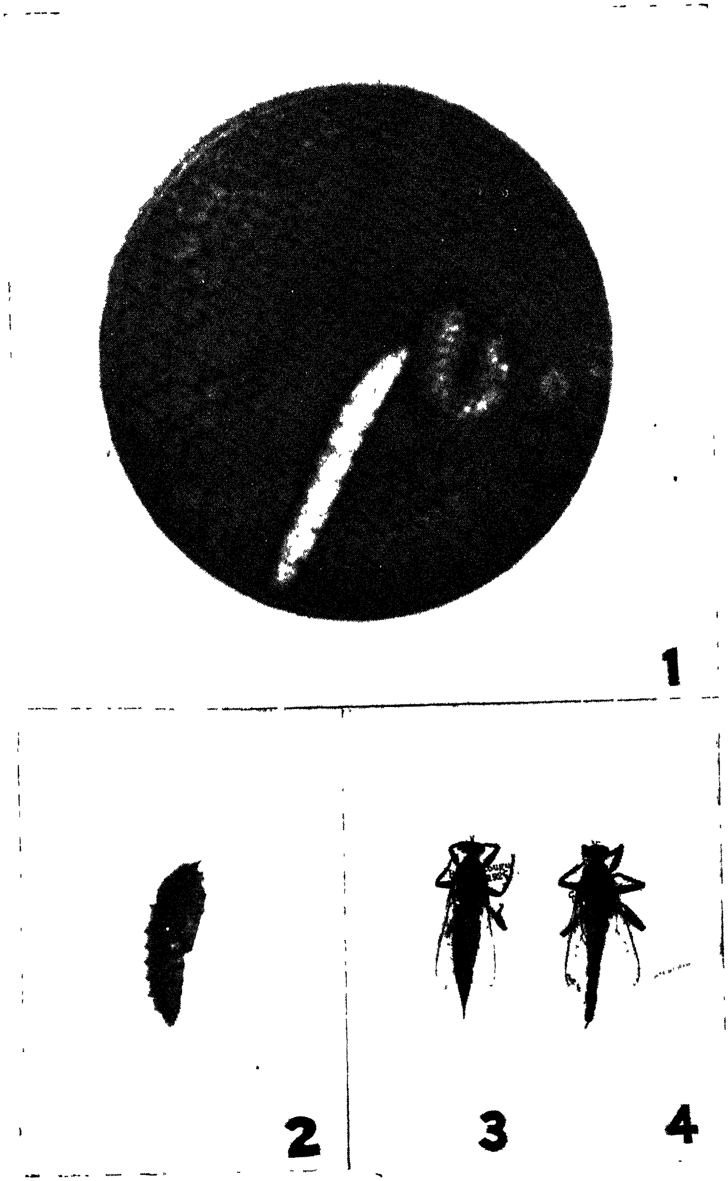
ALDRICH, J. M. A Catalogue of North American Diptera. pp. 275–278. Smithsonian Institute, Washington, D. C. 1905.

BROMLEY, S. W. The Asilidae of Cuba (Diptera). Annals, Entomological Society of America. Vol. 22, No. 2, pp. 272–297. Illust. 1929.

COMSTOCK, J. H. An Introduction to Entomology. pp. 840–841. Illust. Comstock Publishing Co., Ithaca, N. Y. 1925.

DAVIS, J. J. Common White Grubs. Farmers' Bulletin No. 940—30p. Illust. 1922.

Plate 24



Erax interruptus Macq.; 1—Mature larva feeding on white grub, slightly enlarged; 2—Pupa, slightly reduced; 3—Adult female, slightly reduced; 4—Adult male, slightly reduced.

TITUS, E. S. G. Some Miscellaneous Results of the Work of the Bureau of Entomology. U. S. Bureau of Entomology Bulletin No. 54. pp. 15–16. Illust. 1905.
WELLHOUSE, W. H. How Insects Live. An Elementary Entomology. pp. 229–233. Illust. Macmillan Company, New York City. 1926.

THE OCCURRENCE OF *ANTICARSIA GEMMATILIS* AS A SOYBEAN PEST IN LOUISIANA IN 1929

By W. E. HINDS, *Entomologist Louisiana Experiment Station*

ABSTRACT

This tropical species appeared in injurious numbers for the first time in Louisiana in August 1929. It showed a decided preference for soybean varieties rather than velvet beans. The infestation resulting in defoliation of soybeans appeared earliest in the vicinity of Jeanerette, Louisiana and gradually spread northward to the middle of the State. Brief notes on life history, habits and natural enemies were secured. Late in August a general development of a fungus disease believed to be *Empusa rileyi*, checked the further multiplication of the species in an important degree. Insecticidal control was found possible with calcium arsenate containing 5% of hydrated lime and dusted on the dry foliage. Arsenate of lead was not advisable. Sodium silicofluoride of the light dust type, without hydrated lime, gave good control of the worms with very little foliage burning where applied to dry foliage. Poisoned plants put out new growth while unpoisoned plants were completely destroyed and seed setting prevented by the worms.

This tropical species has been known for many years in Florida as a frequent pest defoliating velvet beans. Its occurrence there is reported as being sporadic and its injuriousness seems to depend in considerable degree upon the earliness of its arrival each season. According to Professor J. R. Watson of the Florida Experiment Station, the culture of soybeans was rare in Florida and this caterpillar was not observed attacking soybeans in that State until 1926.

While it is quite certain that the species has occurred in Louisiana in limited numbers before the season of 1929, there is no record to indicate that it has ever occurred in any considerable abundance before that season. On August 14, 1929, as the writer was visiting Professor W. R. Dodson, Superintendent of the U. S. Livestock Experiment Station at Jeanerette, Louisiana, Professor Dodson called attention to the abundance of some species of caterpillar which was defoliating soybeans generally in that section. At that time, in the most advanced cases of injury, the tops of the plants showed the condition which is known as "ragging" in cotton where the cotton leaf worm is in process of stripping that plant. Professor Dodson was largely responsible for the introduction and widespread culture of the soybean in Louisiana and has

been interested for many years in improving varieties of soybeans for use in this State. Some of this variety testing and improvement work was under way at Jeanerette. It was very evident that this new pest on soybeans found certain varieties more susceptible to its attack or more attractive to its taste than were other varieties. Varieties like Otootan and Laredo were stripped much more quickly and completely than varieties like Biloxi which were taller and more open in growth.

The first evidence of stripping was noted by Professor Dodson at Jeanerette during the first week of August and in 10 days time some varieties were as completely defoliated as cotton is following an outbreak of the cotton leaf worm. The worms showed many points of resemblance to the cotton species. They are of practically the same size when full grown and also have the habit of dropping quickly to the ground upon the jarring of the plant on which they are feeding. Some of these resemblances, as well as differences in appearance, may be seen by reference to the illustrations given herewith.

A brief series of observations upon the life history and habits of Anticarsia indicated that the eggs are laid singly and scattered about the plant, especially on the leaf stems and mid-ribs where the pilosity is heaviest. Observation of the act of oviposition indicated that this occurs at about dusk, and is probably continued into the night. In the case observed the females seem to depend upon finding a surface that was quite rough to assist in scraping the egg from the tip of the abdomen as it was deposited. It appears that the developmental periods for eggs, larvae and pupae are very similar to those occurring for the cotton leaf worm and that a new generation may occur at intervals of about 5 weeks.

Pupation in the case of Anticarsia does not occur by webbing up on the plant as is the case with *Alabama argillacea*. When full grown the Anticarsia larvae go to the ground and pupate at or slightly below the surface of the ground, under trash, or buried in the surface soil. Most of the pupae found were not more than 1 inch deep in the soil.

It appears that the adult moths feed on nectar as they occurred in abundance at rows of Crotalaria which were growing near the soybeans but there was no indication of the feeding of Anticarsia larvae on this Crotalaria.

So far as food plants of Anticarsia are concerned, all species or varieties of soybeans were attacked but only very limited feeding occurred on velvet beans growing in adjacent rows at the Louisiana Experiment Station. The only wild food plant observed was the "black locust" (*Robinia pseudoacacia* L.). Tender sprout growth of this species was

stripped completely by Anticarsia larvae but no general stripping of locust foliage occurred.

The advance of Anticarsia from the southern portion of Louisiana, where the earliest stripping occurred, extended northward to the middle of the State. Stripping was common but not complete at Baton Rouge and decreased steadily further north. The peak of the infestation occurred at Jeanerette at about August 20 and at Baton Rouge about 10 days later.

During the height of the infestation a number of natural enemies of Anticarsia were noted attacking it. The English sparrow came by flocks to the infested soybean fields and fed extensively upon the larvae. They were observed to light particularly in the tall erect stiff-growing Biloxi plats. The birds followed the worms to the ground and numbers were seen with worms in their mouths.

Carabidae larvae, of several species, were gorging themselves upon the Anticarsia larvae on the ground. Several species of Vespoid-wasps were abundant in the infested fields and some of them were observed in the act of feeding upon the Anticarsia larvae. Dipterous parasites did not seem to be at all abundant at this time.

Undoubtedly the most effective natural enemy appearing in Louisiana was a fungus disease which destroyed the larvae. This disease appeared as a pure white coating on the bodies of the dead larvae which usually remained attached to the plant near where they had fed last. This disease is believed to be *Empusa rileyi* and has been reported as being very effective in Florida in controlling the fall development of Anticarsia. This disease appeared at Baton Rouge during the last week of August and increased rapidly in its destruction of larvae during the next two or three weeks. It is quite possible that this disease may have been an important factor in preventing further damage by Anticarsia in the fall of 1929.

Insecticidal control measures were tested hurriedly and but partially. The foliage of soybeans is well known to be very susceptible to burning by arsenical applications. However, applications of calcium arsenate mixed with 5% hydrated lime did not burn the foliage seriously and seemed to give fairly satisfactory control of the worms. Low growing soybeans are very difficult to treat effectively with a dust application. The best treatment that could be given was by means of saddle guns, dusting 2 rows at a time. Applications of Jungmann's Extra Light Sodium silicofluoride without hydrated lime gave very fair control of the worms with very little burning of foliage. It appeared that the best time for application of either material was in the late afternoon, usually from about 5:00 P. M. until dark.

Arsenical dusts were applied at the Louisiana Experiment Station too late in the season to secure very satisfactory evidence as to their value in general field applications. However at Jeanerette, Professor Dodson used calcium arsenate extensively, earlier in the season and reported that the treatment checked the worms quite promptly but with some burning of foliage. However, the treated areas were so well protected from further worm attack that the buds in the leaf axils were preserved. Therefore the treated areas put out new foliage promptly and continued a growth which assisted in the maturing of seed in valuable seed plats, while in untreated areas the worms destroyed the buds so thoroughly that no further growth occurred and the seed crop was largely destroyed. It appears, therefore, that arsenical applications, or sodium silicofluoride dust, should be used for the control of *Anticarsia gemmatilis* where the maturity of the seed is desired.

However, if the soybean crop is being grown primarily for forage, or as a green manuring crop, it would seem to be advisable to harvest as soon as the threat of defoliation becomes general, or to plow under the crop at that time.

It is encouraging for soybean growers to know that this species is, apparently, of tropical origin and cannot survive an ordinary winter in Louisiana. All stages except the pupae are destroyed immediately by killing frost and any adults emerging after the first frost would be destroyed, together with their offsprings, if a second frost should occur some 8 or 10 weeks after the first. It is not likely, therefore, that this species will ever be found a regularly occurring, or generally serious pest of soybeans in Louisiana.

Explanation of Plates

Plate 25. *Anticarsia gemmatilis* Hubn.

Fig. 1.—Adults, side, ventral and dorsal aspects; Fig. 2.—Fresh eggs, bluish green, on mid-rib, times 8/1; Fig. 3.—Egg ready to hatch, orange colored; Fig. 4.—Anticarsia larvae showing variations in size and color markings from olive green on left to nearly black at right; Fig. 5.—*Alabama argillacea* larvae for comparison with Fig. 4; Fig. 6.—Anticarsia pupae at left compared with two *Alabama argillacea* pupae at right. All photos original, X ¾ except Figs. 2 and 3.

Plate 26. *Anticarsia gemmatilis* on Soybeans

Fig. 7.—Head capsules of Anticarsia larvae, X 8/1; Fig. 8.—Head capsules of *Alabama argillacea* for comparison with Fig. 7, X 8/1; Fig. 9.—Close view of soybeans nearly defoliated; Fig. 10.—General condition in same area as Fig. 9 after leaf tissue was devoured. All photos original.

Plate 27. *Anticarsia gemmatilis* on Soybeans

Fig. 11.—Fungus disease (*Empusa rileyi?*) destroying larvae of Anticarsia—specimens as found in the field; Fig. 12.—Otootan beans after defoliation; Fig. 13.—Close view in tops of plants shown in Fig. 12. All photos original.

Anticarsia gemmatilis Hubn.

Anticarsia gemmatilis on Soybeans

SOME METHODS OF TRAPPING PLANT LICE

By FRANK M. HULL, *Plant Lice Laboratory, Texas Agricultural Experiment Station*

ABSTRACT

Screens constructed of cheese cloth and voile were tested in comparison to screens made of hardware cloth and coated with tanglefoot. The latter type when developed on the style of a movable wind vane proved the most satisfactory. Eight mesh wire cloth was used and the Tanglefoot thinned by heating before being applied to the screens. The records seem to show that there are two periods of the year more dangerous than others to the crop so far as infestation with lice is concerned. Crops planted at periods when there is little wind movement of lice have an advantage over others.

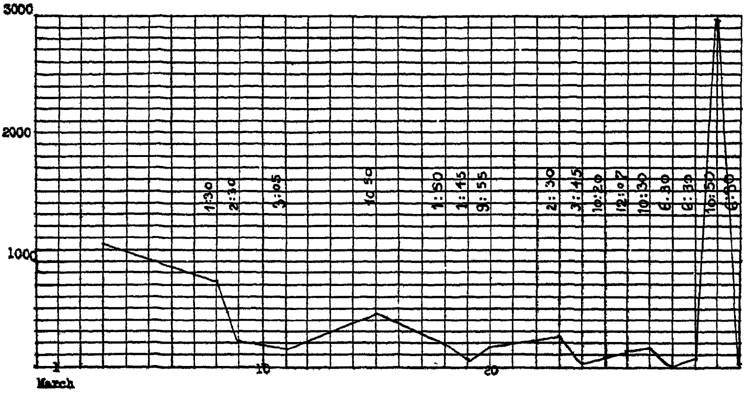
The possibilities along the line of trapping plant lice, especially winged forms, were early seen at the Plant Lice Laboratory and were especially pointed out by Dr. F. L. Thomas. Accordingly experiments in method were begun with the hope of securing data with reference to control.

Last year a number of flat cloth screens were constructed of several fabrics and set up in the field. These vertical screens were found to register a lice flow proportional roughly to the tightness of weave. Thus, contrary to our expectation, voile cloth was much poorer than ordinary cheese cloth. Cheese cloth was the first material tried. It is flimsy and does not last well. It appears to be approximately fifty per cent more efficient, so far as concerns the number of lice caught. In the more solidly woven materials, the air, instead of passing through the screen, veers about and around it. This is to be expected but it carries the lice with it. We tried improving the efficiency of the cloth by coating with molasses syrup and tanglefoot. Neither the tanglefoot nor the syrup can be applied without serving to further close the pores of the fabric and the syrup is washed away with every heavy dew. These screens are shown in Pl. 28, fig. 1.

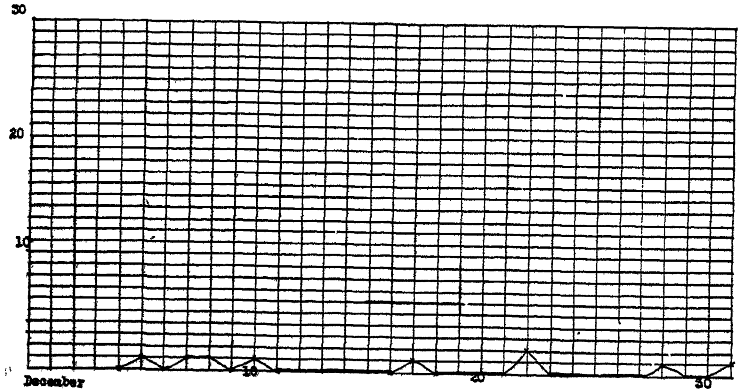
The drawback to cloth untreated screens is the temporary nature of the register. Those lice which come to rest against the cloth crawl away, are blown off, or fall off in the course of time, and such screens cannot be used for periods much greater than one hour with any accuracy.

Tanglefoot was tried first upon ordinary screen wire. It cannot be successfully applied to such wire even when thinned by heating since the meshes are filled up with the sticky substance. We found that if we thinned tanglefoot down greatly with heat and applied it to hardware cloth it can be very successfully used. The meshes of such cloth must not be greater than eight to the inch. Even with mesh of this size the

tanglefoot must be applied with a stiff brush and only hard rubbing back and forth will keep the meshes open. We believe one screen of this type to be sufficient, but we have also arranged a series of larger mesh screens, one upon another, to act as wind filters, and working upon the principle that if the insect does not strike the first one it will strike the second or the third. We have yet no comparative data on the two types.



A.—Graph showing the numbers of lice caught during the spring period of abundance. March,, 1929. The lice are shown in hundreds per hour. It should be borne in mind that the flow is not continuous throughout the day. Most of the records were taken about one or two o'clock in the afternoon; some as late as six-thirty. The hour of each record is shown.



B.—Graph showing the numbers of lice caught during a winter or intermediate period. December, 1929. The lice numbers are shown in individuals per day.

Fig. 61.—Graphs giving an indication of the relative periodicity of the infestation potential for the section.

Two types of screen have been used, one of them fixed in position with walls upon its perimeter and designed to catch the lice drift from one direction only. The other type we designed with a movable vane allowing it to turn with the wind and for the purpose of obtaining weekly records of all lice at certain points. All of these have been vertical traps. We have also used flat boards of beaver board material, painted white and coated with tanglefoot and placed horizontally. Vertical types are much to be preferred since, if they are so constructed that the air passes through them, one can rely upon getting an accurate check on the movement of lice. The movable form of trap is shown in Pl. 28, fig. 2.

Apart from general interest, the trapping of these wind flying forms has a practical value. Whereas the truck season, as far as lice bearing crops are concerned, is some seven months long, the ordinary grower does not distinguish between periods of greater and lesser danger during these seven months. It is our belief, supported by what we have thus far seen, that the lice form their worst menace chiefly during a spring and fall period. There are lice, of course, constantly present in the country, but in late March and early April the production of winged forms is very high and reaches a high period again in the fall. The actual number of fall lice is somewhat lessened by the scantier crops that are grown at that time. There are many periods such as in December of last year where the number of winged forms decreases to nearly none. Tanglefoot screens registered one or two lice per week (per screen of four square feet) during that time, as against several hundred per day in late spring. (See Fig. 61.)

We have been making every effort to bring growers to a realization of the value of planting crops at those periods when laboratory screen records show an atmosphere clear of winged forms. Obviously by so planting the grower can often times give his crop a several weeks start in growth before being infested by wind drift forms which is practically the only potential source of infestation.

RESULTS SECURED ON THE GIPSY MOTH EXTERMINATION PROJECT IN NEW JERSEY

By A. F. Burgess, *Melrose Highlands, Mass.*

In July, 1920 a heavy gipsy moth infestation was found at Somerville, N. J., and a decision was reached that extermination work should be undertaken by the Bureau of Entomology in cooperation with the New Jersey State Department of Agriculture and financed by the Government and the State.

A very hurried examination, extending over about two weeks, indicated that the insect was present in an area of about 100 square miles. Funds were secured by using this area as a basis and the work was begun.

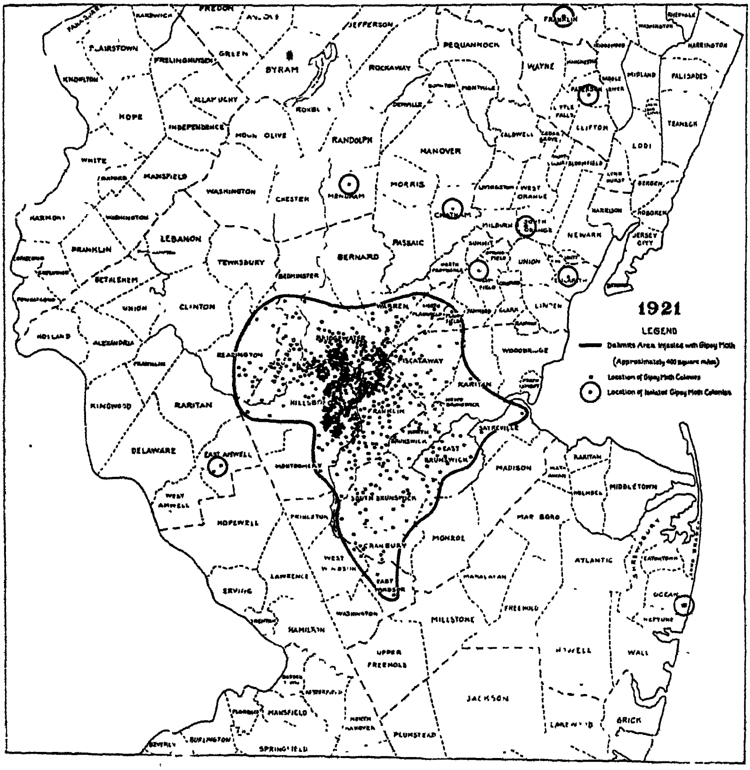
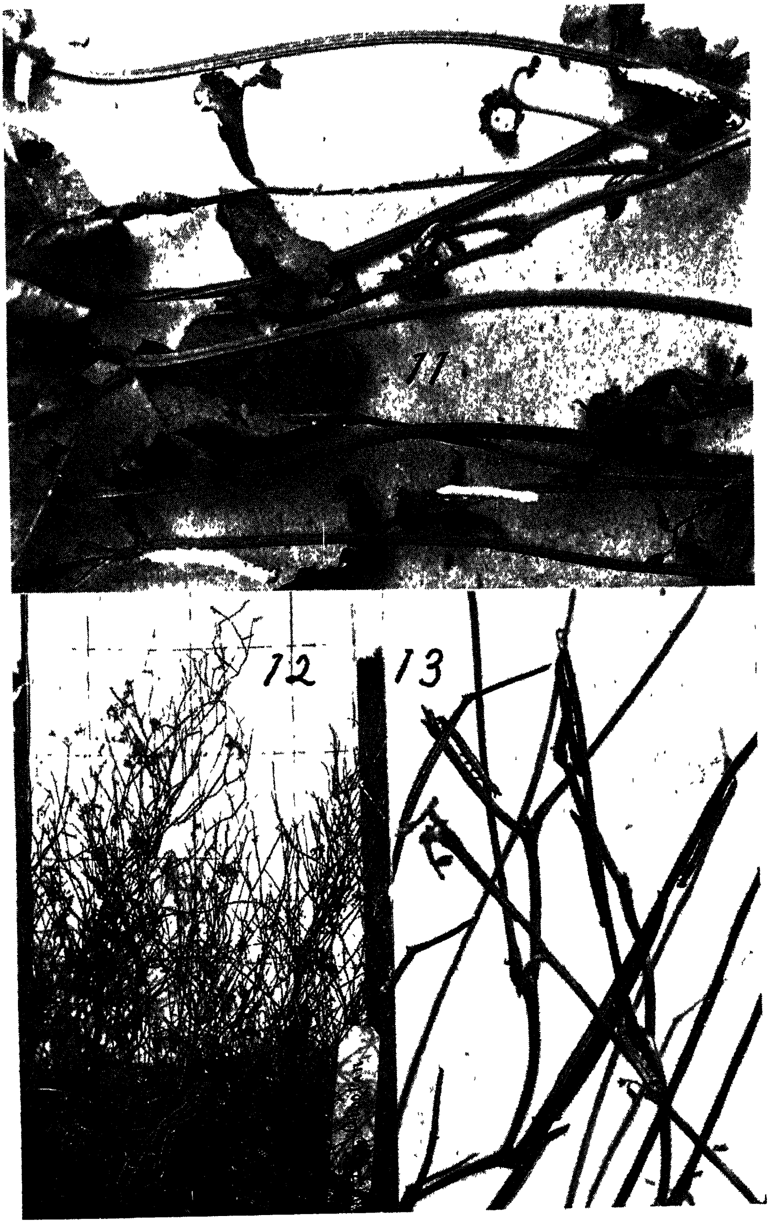
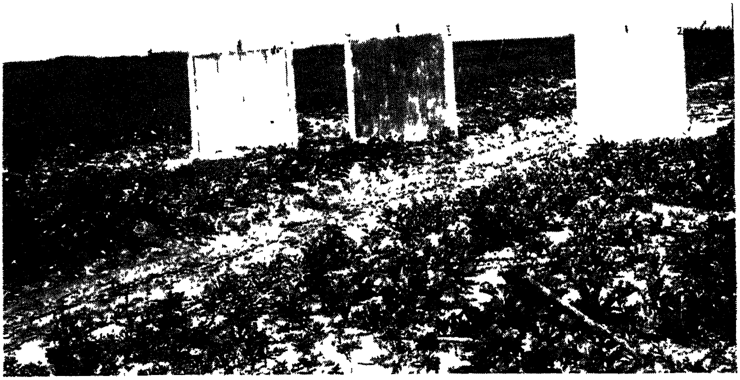


Fig. 62.—Gipsy Moth Project in New Jersey

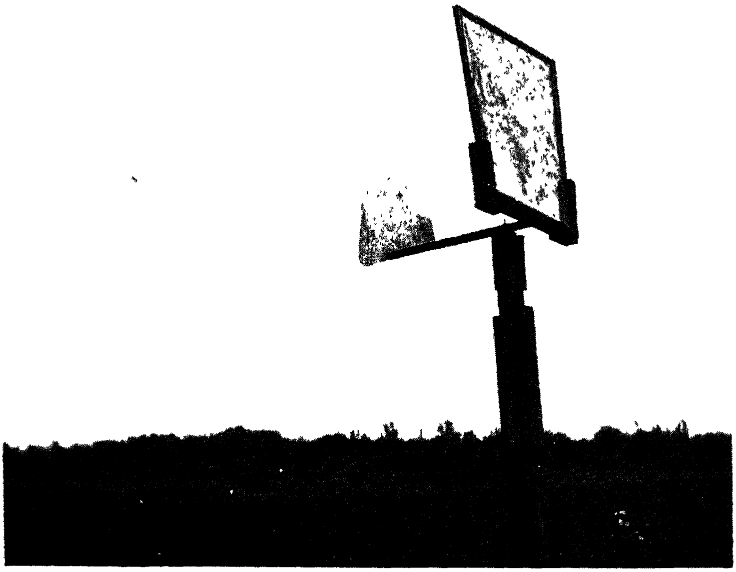
As a result of careful scouting that was continued throughout the following year the pest was found in an area of over 400 square miles, and in addition nine isolated infested points outside the main area were located. The latter resulted from shipments of trees that had been secured from the worst part of the infested area.



Anticarsia gemmatilis on Soybeans



1.—Cheesecloth, voile syrup treated, and plain voile screens, (left to right) being tested for efficiency in catching wind drifted forms of plant lice.



2.—Hardware cloth screen mounted on pivot and turning with the wind. Coated with Tanglefoot. The screen can be taken out of the slot and new ones inserted at what ever intervals are desired.

It is now more than nine years since the insect was found in New Jersey, and intensive eradication work has been carried out throughout that period. In 1920 over 3,000,000 egg clusters were treated, and the following summer thousands of acres of tree growth were sprayed. In 1929 only one small colony with less than 100 egg clusters was found, and the site of this colony and the surroundings required spraying. These results were accomplished by carrying on intensive scouting and

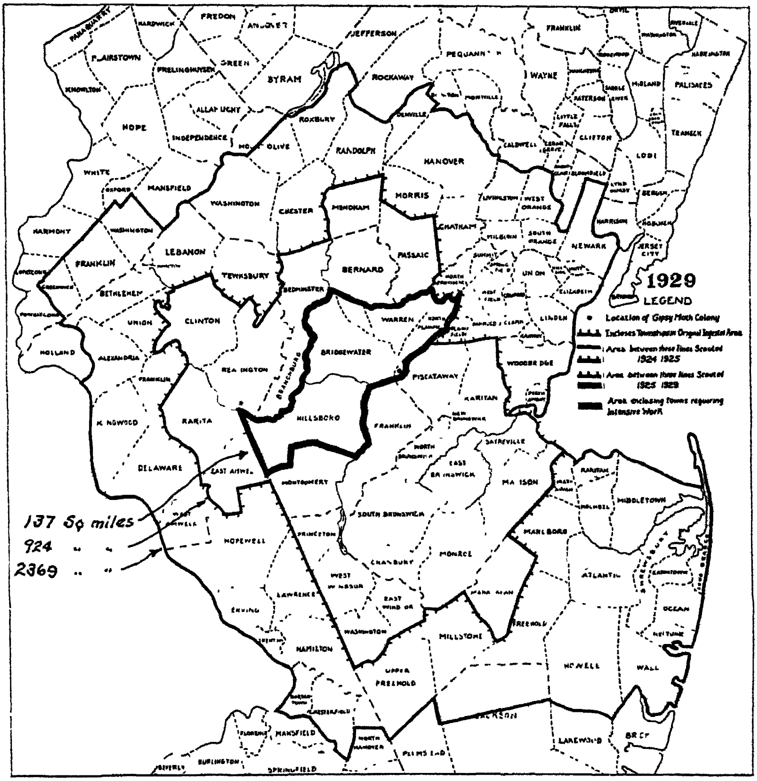


Fig. 63.—Gipsy Moth Project in New Jersey

clean-up work in the badly infested part of the area until the insect was extremely scarce. This was followed by scouting a belt of towns averaging more than 10 miles wide surrounding all of the towns where any infestation had previously been found. During the years that followed, the towns that were farthest removed from the central infestation were intensively scouted, every tree, including those in woodland areas, being examined, and in this way the territory was gradually closed in toward the center.

At the end of the fiscal year 1929, 137 square miles remained to be intensively scouted. The entire area in the State that has been worked is 2,369 square miles, exclusive of the nine isolated colonies that were exterminated within a year or two following their discovery.

The following facts are outstanding:

Original estimate of infested area	100 square miles
Original estimate of time required for extermination	5 years
Original estimate of cost	$1,000,000
Area actually found infested	Over 400 sq. miles
Total area where work was required	2,369 " "
Time spent on project to date	9 years
Total amount expended to June 30, 1929	$2,113,000
Largest annual expenditure (1923)	295,000
Estimated annual expenditure, 1930	120,000
" " " 1931	80,000

Comparing the estimated area infested with that actually found, the expenditures on this project are far less than would be expected. The cost of operation is decreasing each year, and the successful conclusion of the work will be brought about within a reasonable time. It will be necessary to do a small amount of general scouting for several seasons after the area requiring intensive work has been covered, but this can be done at a very moderate cost.

The success of this extermination project, which is the largest that has ever been attempted with an insect of this type, has been due to the effective cooperation of the Federal and State offices concerned, adequate financial support, and the loyal and enthusiastic work of the field organization. Difficulties which frequently seemed insurmountable have been overcome in bringing about these results.

GIPSY MOTH BARRIER ZONE MAINTENANCE PROBLEM

By A. F. Burgess, *Melrose Highlands, Mass.*

In 1923 it was decided that the most effective means of preventing the gradual spread of the gipsy moth throughout New York State and to the States south and west was to establish a zone in which would be carried on such scouting and clean-up measures as would prevent westward movement of this pest.

The area selected averaged about 30 miles in width, extending from the Canadian border to Long Island Sound and embracing over 8,000 square miles. Approximately one-half the area was in New York State

and the balance in Vermont, Massachusetts and Connecticut. The western boundary was the Hudson River and a line extending from its source nearly northward to Canada.

At that time there were known to exist a number of gipsy moth infestations in the zone area and immediate steps were taken to apply exterminative measures. By far the greater part of this area had never been scouted and the utmost efforts of the Federal force in cooperation with the Conservation Department of New York were put forth to determine the conditions that existed throughout the zone. While this zone is the shortest line that can be drawn to use as a barrier and has a very considerable area of fairly level country, still approximately one-half the area is hilly or semi-mountainous and presents many difficulties to an insect control problem.

The natural conditions are not as serious as in the territory to the west which includes the Adirondack and the Catskill Mountains where enormous areas of wild lands and unbroken forests occur, or to the east where the highest ranges of the Green Mountains in Vermont and portions of the Berkshire Hills in Massachusetts extend southward into Connecticut.

Fortunately at the time this work was undertaken, the region immediately east of the zone harbored very few infested areas; and in the territory between the Connecticut River and the Atlantic seaboard the density of infestation had appreciably declined due to the effect of introduced natural enemies, the application of intensive suppression work and high mortality of the eggs of the insect during several particularly severe winters. As the female moths do not fly, the principal means of natural dispersion is due to wind drift of newly-hatched caterpillars, and the possibility of spread is greatly increased in heavily infested areas.

Under these conditions work was started in the Barrier Zone. During the first two years it was possible to scout thoroughly all the town and city trees, the roadsides, farms, and orchards, as well as isolated woodland areas of small acreage. In the case of solid woodland only the borders were examined except in particularly suspicious localities, as long years of experience had shown that dense woodland was rarely found infested unless there were heavily infested regions within a few miles and because in certain sections, particularly in the northern part of the zone, solid stands of conifers, which are less succeptible to the insect than deciduous growth, were common.

This survey, made during the fiscal years 1924 and 1925, clearly indicated that the inauguration of the project was timely, as more than

50 infested areas were found well distributed throughout the zone. A vigorous colony was also found by the Canadian officials in the Township of La Colle which adjoins New York on the international border. Effective treatment was applied to all the infested areas and in the

Fig. 64.—Gipsy Moth Barrier Zone

course of the next three years all of these infestations had been exterminated. Had this work been postponed or delayed, large areas in eastern New York would have become infested. Some of these colonies were located near the western boundary of the zone, and contiguous

territory outside the zone was examined in 1927 as a precautionary measure. Three colonies were found at and directly west of Kingston, N. Y. The value of this work is evident as it made possible the prompt extermination of these outbreaks. Several groups of towns were also examined which adjoined the zone on the east in Vermont and Connecticut. Three vigorous colonies were found in towns adjoining Rutland, Vt., which would have subjected the adjoining area to reinfestation if cleanup work had not been applied without delay

During the fiscal year 1927 only 21 infested points were found in the entire zone, which was the smallest number since the work began.

The finding of the infestation near Rutland, Vt., caused considerable apprehension that similar infestations might be present east of the zone line which would furnish an opportunity for reinfestation of the region which was being scouted and cleaned. The danger was further increased by the fact that the density of infestation in the territory east of the Connecticut River was greater than during the preceding years.

This led to strong recommendations that work should be done in the towns between the zone and the Connecticut River as far north as Rutland, Vt., in order that any large colonies might be discovered and treated so that spread to the zone would be prevented. Up to the present time no funds have been made available for this purpose.

The following table indicates the condition of infestation east of the zone based on the acreage of defoliation:

1924	825	acres
1925	48,560	"
1926	80,822	"
1927	140,920	"
1928	262,514	"
1929	551,133	"

This increase in defoliation means increase in the possibility of reinfestation of the zone. During the last few years small defoliated areas have occurred in a number of towns west of the Connecticut River. The number of infested locations in the zone has increased each year since 1927. For the year ending June 30, 1929, one hundred and one (101) were found and treated, the greatest number being in southwestern Massachusetts and northwestern Connecticut and in the adjoining territory in New York State. A considerable number of these colonies were found in woodland, and since July 1 particular attention has been paid to scouting all woodland areas in this section of the zone that have not been examined in recent years.

This is slow and laborious work but is the only means of finding and cleaning up this section of the zone which seems to be particularly subject to reinfestation from the east.

About 25% of the proposed scouting work for the fiscal year had been completed November 20, 1929, and 56 infested locations had been found. Whether there will be a corresponding increase in number of infestations as the work progresses cannot be determined at this time.

All infestations found are treated thoroughly in order that spread of the pest may be prevented. This is accomplished by treating the egg-clusters with creosote, by spraying after the larvae have hatched, or a combination of both methods, depending on the local conditions where the infestation is found. The application of tree banding material to keep the caterpillars from reaching the tops of the trees is sometimes advisable as an auxiliary to creosoting or spraying.

The principal problem in connection with the maintenance of the barrier zone under present conditions is to keep this vast area reasonably free from infestation while the insect is increasing in the territory to the east. So long as these conditions continue, the task of maintaining the zone in its present locations is beset with increasing difficulty and unless some protection can be afforded from the continued reinfestation of the territory that is cleaned up, a relocation of the zone in more difficult territory will be the eventual result.

In connection with the zone work, but indirectly related to it, is the pressing need for scouting a section directly east of the barrier zone south of the international line in Vermont and the territory contiguous to the quarantine line in northern New Hampshire and Maine. This work would make possible the relocation of the quarantine line based on the findings. It would also safeguard the shipment of products proceeding from towns that may now be infested, and give an opportunity to release from the quarantined area towns that are not infested.

Another point that might be stressed at this time is the fact that the tremendous battle that is being waged to prevent this insect from becoming widely distributed over the United States is chiefly for the benefit of the States that are not now infested. It is natural to worry most about the dangers that are nearest home. The person who is forced to pay the price of combating insects because they are present and from which he is unable to escape, in time becomes reconciled to the annoyance and expense involved and does not fully appreciate the losses that are accruing each year.

On the other hand, there is usually a lack of interest in dangerous conditions that may exist a long distance from home and a failure to

actively support projects the purpose of which is protective and preventive rather than actual correctional work after the damage occurs.

Those who are familiar with the gipsy moth and its work entertain no doubt that this insect would cause appreciable damage and loss to forest and shade trees in the area west of the Barrier Zone. The Barrier Zone gives the first protection to the central part of New York, New Jersey, and Pennsylvania. The maintenance of this zone by the Federal government and the State of New York has for nearly ten years been the means of confining the infestation of the gipsy moth to the New England area. It has demonstrated the value of this zone in protecting the uninfested regions to the west.

OVIPOSITION OF THE CORN EARWORM MOTH IN RELATION TO NECTAR FLOW OF SOME FLOWERING PLANTS[1]

By J. W. Nuttycombe

Abstract

Studies at Charlottesville, Va., indicate that food is a strong factor in determining the number of eggs deposited by corn ear worm moths (*Heliothis obsoleta* Fab.). These moths feed upon the nectar from the blossoms of a great variety of plants, the overlapping flowering periods of which cover the oviposition period of the moths. Nectar flow from these plants, although greatly curtailed by drought, is apparently never so reduced as greatly to affect oviposition; consequently search must be made elsewhere for factors causing marked disturbances in the normal seasonal abundance of the eggs.

Some observations made at Charlottesville, Va., on the variations in the seasonal abundance of the eggs of the corn earworm (*Heliothis obsoleta* Fab.) have indicated that the abundance or scarcity of the food supply for the moths in nature may be a decided factor in determining the number of eggs deposited during a given period. Thus during an exceedingly dry period the nectar flow might be so slight as to afford little food for the moths, and consequently the number of eggs deposited during such a drought would be greatly reduced.

That the quantity of food ingested does affect the longevity of the moths and the number of eggs deposited by them has long been known. Quaintance and Brues (U. S. Dept. Agr., Bur. Ent. Bull. 50, 1905. "The Bollworm. . .") state that "Abundance of suitable food appears to be a vital necessity for the normal longevity of the moths" and "Oviposition does not really begin until after the female has been able to partake of food."

[1]This work was done under the direction of W. J. Phillips, of the U. S. Entomological Laboratory, Charlottesville, Va.

In an effort to determine the importance of this food factor, more than twenty of the nectar producing plants were studied. An attempt was made to ascertain upon which of these plants the moths fed, and which of them yielded sufficient nectar to materially affect oviposition.

The author has observed moths in captivity, and in nature, feed, or attempt to feed from blossoms of the following plants:

Alfalfa (*Medicago sativa* L.)
Button-bush (*Cephalanthus occidentalis* L.). (In nature.)
Catnip (*Nepeta cataria* L.).
Cone-flower (*Rudbeckia* sp.).
Cowpea (*Vigna sinensis* L.). (In nature.)
Daisy (*Chrysanthemum* sp.).
Dog-fennel (*Anthemis cotula* L.).
Erigeron (*Erigeron* sp.).
Hop clover (*Trifolium agrarium* L.).
Horse-nettle (*Solanum carolinense* L.)
Indian hemp (*Apocynum cannabinum* L.).
Joe-Pye weed (*Eupatorium purpureum* L.) (In nature.)
Milfoil (*Achillea millefolium* L.)
Milkweed (*Asclepias syriaca* L.).
Rabbit-foot clover (*Trifolium arvense* L.).
Red clover (*Trifolium pratense* L.).
Sumac (*Rhus* sp.).
White clover (*Trifolium repens* L.).
Wild astor (*Aster* sp.). (In nature.)
Wild carrot (*Daucus carota* L.).
Wild onion (*Allium vineale* L.).
Wild vetch (*Vicia* sp.)

Fifty-three female moths were used in an attempt to determine the effect of food, as found in nature, upon the number of eggs deposited. The female moths, together with males, were placed in glass cylinder cages covered by cheese cloth. Cut blossoms of the food plant to be tested were placed in a vase and then introduced into the cage, and thereafter replaced daily by fresh blossoms. All tests were made during the normal flowering periods of the plants as shown in Figure 65. In all cases, except that of goldenrod, the moths fed, or attempted to feed, several times each day. Conditions of temperature, humidity, etc., were approximately the same in all cages used. In this way 16 different food groups were tested. In Table 1, which follows, the plants are arranged in the order of the number of eggs deposited, from higher to lower. The average number of eggs per moth and the average longevity of the females segregated with each food group are also shown.

Although the actual amount of nectar available under these conditions can only be estimated from effect upon the number of eggs deposited, the data obtained from these studies are indicative that food is a decided factor in the determination of the number of eggs deposited. The fact that few or no eggs were obtained from moths on several of the plants tried as food does not necessarily indicate that these plants may not supply nectar for the moths in nature. The evidence here adduced is merely not positive that they do supply nectar for moths. On the other hand, several of the plants considered in Table 1 quite evidently yielded sufficient food to increase materially the number of eggs de-

posited. Among this latter group may be listed alfalfa, red clover, joe pye weed, milk weed, indian hemp, white clover, daisy, and horse nettle.

TABLE 1. EXPERIMENT TO DETERMINE EFFECT OF THE PRESENCE OF BLOSSOMS OF VARIOUS FOOD PLANTS UPON THE NUMBERS OF EGGS DEPOSITED AND THE LONGEVITY OF CORN EARWORM MOTHS

Food plant	Number of female moths	Aver. Number of eggs	Aver. length of life (days)
Alfalfa	3	582	8½
Red clover	5	477	7
Joe-Pye weed	1	430	9
Milkweed	2	365	8
Indian hemp	4	354	9
White clover	4	328	8
Daisy	5	254	6½
Horse nettle	2	242	6
Wild onion	2	185	10
Wild vetch	2	158	9½
Erigeron	4	85	8
Milfoil	3	63	8½
No food	9	53	7
Wild carrot	2	28	7
Sumac	3	14	6
Golden-rod	2	0	6½

The studies covered in this paper were made between June 1 and October 3 of 1927 and 1928. Figure 65 gives a list of some of the plants occurring in the vicinity of Charlottesville which might furnish more or less food for moths, the probable limits (within the periods of study) of the flowering period of each plant, and the names of other insect groups which were observed to feed at the flowers. Quite naturally the flowering periods and the nectar yield of each species are dependent to a great extent upon the nature of the season. The limiting dates for the table are those for the relatively small areas under observation and are probably not absolutely inclusive for this region.

Surveys made in lowlands about three miles outside of Richmond, Va., during 1927 and 1928, showed that the nectar yielding plants there were substantially the same species as those found at Charlottesville. The most important exception was the button bush (*Cephalanthus occidentalis* L.) which, at Richmond, furnishes an extremely abundant supply of nectar between July 10 and August 5 (limits for 1928). This plant was not observed at Charlottesville during these studies.

No attempt was made to determine the flowering limits of soy beans and cow peas and a few other cultivated plants because different fields of these are in bloom continuously from early July until frost, depending on the planting date. Moths were observed feeding on cow peas (*Vigna sinensis* L.) in large numbers.

In addition to the determination of the flowering limits of the possible nectar plants an attempt was made to estimate whether or not nectar was being secreted throughout the season, particularly during periods of temporary drought. Honey bees and bumble bees (in the case of red clover) were captured while visiting the plants listed below and their honey stomachs examined. These examinations were made throughout the summer, a week or ten days apart and several (usually five) bees were used for each examination. Bees from Erigeron, sumac, milfoil, daisy, rabbit-foot clover, white clover, red clover, indian hemp, water hemlock, iron weed, Joe-Pye weed, wild onion, cone flower, and golden rod were examined during the period within which the plants flowered. The data thus collected showed that, even though the nectar flow was curtailed during dry periods, there was always a considerable quantity of nectar available, particularly in the bottomlands where the drought was less severe. The bottomlands considered were adjacent to the uplands and the difference in elevation rarely exceeded 100 feet. The flowering periods of the various plants of the series are shown in Figure 65 and it may be noted that the periods represented by the plants from which bees were examined cover the entire period between June 6 and October 3. In view of the fact that the moths are extremely strong fliers and might, if necessary, migrate to the lowlands for feeding if there were a dearth of nectar from upland flowers, it seems unlikely that there is ever such a scarcity of nectar as would seriously affect the food supply of the moths and thus materially reduce the number of eggs deposited.

In addition to the plants mentioned in this paper, there are numerous other species which, though less plentiful, in agregate would yield much nectar. Probably the bulk of these plants fall in the families Leguminosae, Compositae, and Labiatae.

These studies indicate that for this locality:

1. Food is an important factor in determining the number of eggs deposited by the moths.

2. The moths feed on the nectar from a great variety of plants.

3. The overlapping flowering periods of these plants cover the period during which oviposition occurs.

4. Nectar flow, though greatly curtailed by drought, is apparently never so reduced as to greatly affect oviposition.

5. And, consequently, we must look elsewhere for factors causing marked disturbances in the normal seasonal abundance of the eggs.

PLANTS	Insect groups feeding on flowers in nature
Milfoil *Achilleo millefolium*	Coleoptera, Diptera, Hemiptera, Hymenoptera, Lepidoptera
Wild onion *Allium vineale*	Honey bees, other Hymenoptera, Lepidoptera
Dog fennel *Anthemis cotula*	
Indian hemp *Apocynum cannabinum*	Honey bees, other Hymenoptera, Coleoptera, Diptera, Lepidoptera
Milk weed *Asclepias syriaca*	Coleoptera, Hymenoptera, Lepidoptera
Aster *Aster* sp.	Honey bees, other Hymenoptera, Coleoptera, Hemiptera, Lepidoptera
Thistle *Cirsium lanceolatum*	Hymenoptera, Lepidoptera
Daisy *Chrysanthemum* sp.	Coleoptera, Hemiptera, Hymenoptera, Lepidoptera
Water hemlock *Cicuta maculata*	Honey bees, Coleoptera, Diptera
Clematis *Clematis virginianum*	Honey bees, other Hymenoptera
Bind weed *Convolvulus* sp.	Coleoptera, Diptera, Hymenoptera
Jimson weed *Datura stramonium*	Lepidoptera
Wild carrot *Daucus carota*	Coleoptera, Diptera, Hemiptera, Hymenoptera
Flea bane *Erigeron* sp.	Honey bees, other Hymenoptera, Coleoptera, Diptera, Hemiptera, Lepidoptera
Joe Pye weed *Eupatorium purpureum*	Honey bees, other Hymenoptera, Diptera, Lepidoptera
Morning glory *Ipomoea purpurea*	Bumble bees
Honey suckle *Lonicera*	Bumble bees, Lepidoptera
Alfalfa *Medicago sativa*	Bumble bees, Lepidoptera
Smart weed *Polygonum* sp.	Honey bees, other Hymenoptera
Sumac *Rhus* sp.	Honey bees, other Hymenoptera, Diptera
Yellow iron weed *Ridan alternifolius*	Honey bees, other Hymenoptera, Coleoptera, Hemiptera, Lepidoptera
Cone flower *Rudbeckia* sp.	Honey bees, bumble bees, other Hymenoptera, Lepidoptera
Horse nettle *Solanum carolinense*	Bumble bees, Lepidoptera
Golden rod *Solidago* sp.	Honey bees, bumble bees, Coleoptera
Hop clover *Trifolium agrarium*	Honey bees, Coleoptera
Rabbit foot clover *Trifolium arvense*	Honey bees, bumble bees
Red clover *Trifolium pratense*	Bumble bees, Lepidoptera
White clover *Trifolium repens*	Honey bees, Lepidoptera
Iron weed *Vernonia* sp.	Honey bees, other Hymenoptera, Lepidoptera
Wild vetch *Vicia augustifolia*	Bumble bees, Lepidoptera

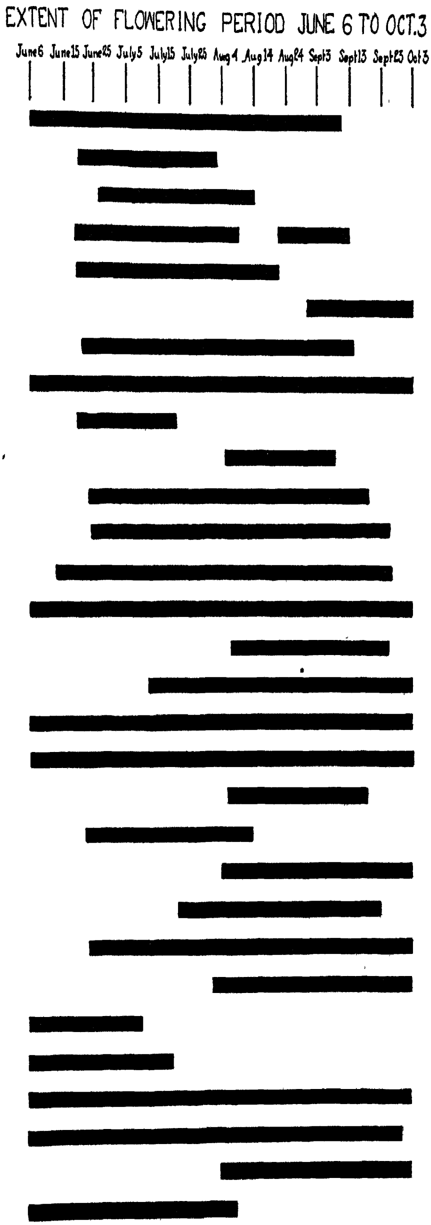


Fig. 65.—A list of some of the plants for the vicinity of Charlottesville which might furnish food for corn earworm moths, the probable limits of the flowering period and other insect groups which were observed to feed at the flowers.

SECOND REPORT ON SOME OF THE MORE IMPORTANT INSECTS CAPTURED IN CODLING MOTH TRAP BAITS, YAKIMA, WASH., 1927–28[1]

By M. A. YOTHERS, *Associate Entomologist, Deciduous Fruit Insect Investigations, U. S. Bureau of Entomology, Yakima, Wash.*

ABSTRACT

In experiments with trap baits for capturing the codling moth, *Carpocapsa pomonella* L., many other insects were captured. Observations on the earliest and latest appearances and times of maximum numbers are presented for some of the more important of these, such as the clover-hay moth, *Hypsopygia costalis* Fab., the oblique-banded leaf-roller, *Archips rosaceana* Harr., the Chrysopas and the Noctuids.

EXPERIMENTS IN 1927

Experiments with codling-moth trap baits in 1927 were carried on in three orchards, each of which differed greatly from the others in its cultural condition and in the care taken of it with reference to the codling moth.

THE J. H. WRIGHT ORCHARD. The test in the J. H. Wright orchard consisted of the use of 100 3-pint enameled kettles of molasses ferment,[2] one in each tree, and their operation from May 16 to September 18. The kettles were suspended from the under side of limbs in the top third of 25-year-old apple trees. In this tract, and in the remainder of the orchard surrounding it on three sides, were occasional bunches of alfalfa and sparse miscellaneous weeds, but not enough of all to constitute a real cover crop. The codling moth infestation had been considerable during previous years, but this season, owing perhaps to an extra heavy spraying program, the infested fruit was probably not over 10 per cent of the crop. The crop of fruit was extremely light.

These baits, placed out on May 16 and examined for insects regularly every 5 days to September 18 (Table 1), caught the first codling moths by the time of the first examination, May 21, the maximum number for the spring brood June 20, and the maximum number for the combined late broods about the middle of August. After the termination of the experiment, September 18, probably very few codling moths were present.

[1]The first report on this subject appeared in the Journal of Economic Entomology, Volume 22, Number 5, pp. 805–811, October, 1929.

[2]Molasses 1 part, water 15 parts+yeast (1 cake, ½ oz., to the gallon).

TABLE 1. RECORD OF SOME OF THE MORE IMPORTANT INSECTS CAPTURED IN ONE HUNDRED TRAP BAIT PANS, J. H. WRIGHT ORCHARD, YAKIMA, WASH., 1927

Date	Codling moths	Noctuids	Chrysopa spp.	Clover-hay moths	Leaf-rollers (Archips rosaceana)
May 21.......	12	351	12	—	—
26.......	50	249	16	—	—
31.......	26	243	16	—	—
June 5........	332	200	54	2	—
10.......	108	199	22	40	—
15.......	370	213	27	15	6
20.......	413	249	53	70	13
25.......	154	214	42	106	11
30.......	68	149	40	78	5
July 5........	180	374	93	268	8
10.......	166	687	73	638	12
15.......	89	484	57	615	6
20.......	40	545	71	1,019	9
25.......	88	810	223	1,573	10
30.......	192	808	448	944	4
Aug. 4........	273	803	391	761	—
9........	611	1,291	775	992	—
14.......	208	1,182	463	393	—
19.......	459	1,091	629	371	12
24.......	470	2,773	953	223	—
29.....	129	4,512	1,048	74	—
Sept. 3........	52	4,363	688	75	—
8.........	46	3,875	368	104	—
13.......	5	2,845	180	128	—
18.....	70	3,165	586	148	66
Total.....	4,611	31,675	7,328	8,637	162

Noctuids were captured in considerable numbers from the start, but in increasing numbers throughout the remainder of the season, there being nearly as many at the end of the test as at the time of the maximum capture, about the last of August.

Lace-wing flies, *Chrysopa* spp., were captured in very small numbers until about July 25, after which they were present in considerable numbers.

The clover-hay moth, *Hypsopygia costalis* Fab., did not appear in the baits until June 5, after which it was captured in increasing numbers to the end of the test.

The oblique-banded leaf-roller, *Archips rosaceana* Harr., appeared a little later than the clover-hay moth or on June 15, with only occasional captures throughout the season.

THE C. H. HINMAN ORCHARD. The C. H. Hinman orchard, consisting of 5 acres of 20-year-old apple trees, was bounded on two sides by other orchards. It had a heavy cover crop of alfalfa and a luxurient growth of miscellaneous weeds. The two bounding orchards and the two additional sides were all in alfalfa. It had been badly infested with the

codling moth (about 35 per cent) the previous season, but a very efficient spray program reduced the percentage of infested fruit to probably less than one-fourth of 1 per cent.

TABLE 2. RECORD OF SOME OF THE MORE IMPORTANT INSECTS CAPTURED IN 60 TRAP BAIT PANS, C. H. HINMAN ORCHARD, YAKIMA, WASH., 1927

Date	Codling moths	Noctuids	Chrysopas	Clover-hay moths	Leaf-roller (Archips rosaceana)
May 5	—	—	1	—	—
7	—	3	0	—	—
9	—	15	2	—	—
10	—	12	0	—	—
11	—	17	0	—	—
14	16	63	2	—	—
17	129	54	3	—	—
20	2	83	0	—	—
23	2	180	8	—	—
26	9	40	3	—	—
29	3	135	0	—	—
June 1	78	382	29	—	—
4	334	151	45	5	—
7	194	190	19	5	—
10	56	178	14	25	—
13	79	218	10	79	5
16	220	326	71	322	14
19	191	236	54	267	18
22	147	293	83	572	7
25	37	236	14	316	1
28	14	229	64	681	1
July 1	24	262	102	1,252	4
4	41	129	64	1,279	22
7	48	256	90	1,498	11
10	59	157	93	2,465	2
13	34	222	41	2,735	5
16	23	232	48	2,760	12
19	42	187	45	4,055	7
22	26	192	47	4,605	1
25	40	142	66	3,615	3
28	79	199	76	4,640	0
31	183	235	97	4,885	0
Aug. 3	156	515	123	4,430	2
6	568	506	208	3,526	2
9	503	652	290	3,015	3
12	200	632	205	1,330	1
15	214	848	260	1,441	1
18	637	1,745	598	1,685	2
21	597	3,420	865	1,030	0
24	208	2,787	367	428	0
27	64	3,820	382	458	0
30	25	3,262	259	271	0
Sept. 2	24	2,940	289	375	0
5	32	3,024	255	732	0
8	7	1,666	138	126	0
11	1	1,228	75	159	0
Total	5,346	32,299	5,505	55,067	124

The trap baits were installed May 4, examined every 3 days (after the daily examination of the first few days), and discontinued September

11. Various kinds and strengths of baits were used in the 60 3-pint enameled kettles, but even so there is a marked uniformity of results, in so far as dates of occurrence are concerned, with the Wright orchard where molasses ferment bait was used throughout the season.

Although the baits were placed May 4, no insects of any kind, except one Chrysopa, were captured on the 5th. Codling moths began to appear May 14, reaching the maximum for the spring brood about the first or second week of June. From June 22 to late July comparatively few codling moths were caught, but there was a considerable increase from July 31 to August 24, after which there was a gradual decline to the end of the season.

Noctuids began to appear shortly after the test was started, or on May 7, after which they were present in considerable numbers until the middle of August, when they came in much greater numbers even to the end of the experiment.

TABLE 3. RECORD OF SOME OF THE MORE IMPORTANT INSECTS CAPTURED IN 56 TRAP BAIT PANS, WEST BROADWAY, YAKIMA, WASH., 1927

Date	Codling moths	Noctuids	Chrysopa spp.	Clover-hay moths
July 28	199	222	32	1,130
30	264	431	90	2,425
Aug. 1	599	531	171	2,920
3	419	845	172	1,775
5	995	800	237	1,185
7	965	694	236	836
9	921	702	243	1,070
11	678	935	199	481
13	11*	621	75	142
15	422	767	171	415
17	515	1,233	245	807
19	485	1,610	389	830
21	492	1,617	198	368
23	489	2,579	159	358
25	93*	1,754	75	247
27	56	2,197	84	246
29	40	2,428	29	167
31	10	1,559	21	83
Sept. 2	55	2,094	24	208
4	15	1,515	5	309
6	56	1,809	35	378
8	0	827	1	35
10	2	1,620	7	211
Total	7,781	29,390	2,898	16,626

*A sudden drop in the daily mean temperature on August 11 and 12, from 78° F. to 56.5° F., caused a tremendous falling off in the number of each kind of insect captured, especially the codling moth, which is apparently more keenly responsive to such temperature changes than any of the other insects caught. This was also true, although in a somewhat less degree, on August 23 and 24, when the daily mean temperature fell from 74° F. to 63° F.

Chrysopas appeared from almost the start, then in greater numbers throughout June and July, and in still greater numbers throughout August, with a sudden decrease after September 5–8.

The clover-hay moth did not make its appearance until June 4, after which it increased very rapidly, becoming most abundant in the latter half of July, and decreasing after the first week of August.

No leaf-rollers were caught until June 13, after which a few were captured at intervals until August 18.

THE WEST BROADWAY ORCHARD. The West Broadway orchard was a neglected, entirely uncared for orchard. There was a fair cover crop of alfalfa and miscellaneous weeds. The fruit was 100 per cent wormy and so no effort was made to harvest it. Several kinds of baits were tested. Tests were begun July 26 and terminated on September 10.

Records of captures of codling moths showed results similar to those made in the other two orchards—the moths were on the increase in late July, reached maximum abundance during the first week of August, and their numbers suddenly dropped off after August 23.

Noctuids were on the increase from the beginning of the test until about the last of August, after which there was a decrease, although they were still attracted in large numbers up to the end of the experiment.

Chrysopas were also on the increase from the beginning of the experiment until about the 19th of August, after which there was a pronounced decline to the end of the test.

The clover-hay moth was at about its maximum during the first few days of the test, and decreased in numbers, although more or less irregularly, after about August 9.

EXPERIMENTS IN 1928

The main experiments in 1928 were conducted in the A.B. Haueter orchard, where 170 traps were operated in 5 acres of old apple trees of several varieties. The orchard had an alfalfa cover crop and was surrounded on all four sides by other orchards, three of which had cover crops and the fourth, clean cultivation. Owing to improper care in previous seasons, and to the fact that this season it had only one or two careless applications of spray for the spring brood, there was a tremendous codling moth infestation during the tests, and no fruit was harvested.

Tests were not begun until July 24, consequently no records are available for the first half of the season. This year, records of only the codling moth and the clover-hay moth were made.

On July 26, at the time of the first examination, both codling moths and clover-hay moths were abundant and continued so, with variations, until about the beginning of the second week in September, after which there was a distinct and abrupt falling off of both species. While both species were captured in greater numbers at the first and second examinations than at any other time, this may be partly due to captures at these dates of accumulated insects.

TABLE 4. NUMBER OF CODLING MOTHS, *Carpocapsa pomonella* L., AND CLOVER-HAY MOTHS, *Hypsopygia costalis* FAB., CAPTURED IN TRAP BAITS, A. B. HAUETER ORCHARD, YAKIMA, WASH., 1928

Date	Codling moths	Clover-hay moths	Date	Codling moths	Clover-hay moths
July 26......	5,738	2,930	Aug. 21.....	5,171	330
28......	7,191	2,874	23.....	3,644	477
30......	6,592	2,040	25.....	5,158	704
Aug. 1.......	3,101	1,538	27.....	2,101	413
3.......	2,194	600	29.....	1,126	400
5.......	4,459	562	31.....	2,294	930
7.......	5,305	1,426	Sept. 2......	3,216	1,046
9.......	5,178	1,492	4......	3,200	797
11......	3,865	1,140	6*.....	2,078	547*
13......	3.005	552	8......	492	85
15......	3,194	233	10.....	793	153
17......	5,661	892	12.....	470	74
19......	6,588	558	14.....	22	101
Total..................				91,836	22,894

*The number of bait pans operated up to and including this date was 171; thereafter, it was 143.

Table 5 summarizes the records of earliest, and maximum and latest captures of the different kinds of insects in the several orchards in the years 1926, 1927, and 1928. The records for 1926 are taken from the author's first report on this subject, previously cited. The spring season of 1926 was extremely early and consequently not only the codling moth but each of the other insects appeared earlier that year than in other years.

In addition to the foregoing insects there were also many small Diptera, a few Vespas, large Diptera, grass moths, syrphus flies, butterflies, Hemerobiids, Membracids, and an occasional box-elder leaf roller (*Cacoecia semiferana* Walk.), a species of Peronea, and the apple pandemis (*Pandemis pyrusana* Kearf.).

TABLE 5. TIME OF EARLIEST AND LATEST APPEARANCE AND MAXIMUM NUMBERS, BY YEARS AND ORCHARDS, OF SOME OF THE MORE IMPORTANT INSECTS CAPTURED IN CODLING MOTH TRAP BAITS, YAKIMA, WASH.

		Codling moth						Clover-hay moth			Chrysopas			Noctuids			Oblique-banded leaf-roller		
		Spring-brood moths			Late-brood moths			Date of			Date of			Date of			Date of		
		Date of																	
Year	Orchard	First	Max.	Latest	First	Max.	Latest	First	Max.	Latest	First	Max.	Latest	First	Max.	Latest	First	Max.	Latest
1926	Wright[1]	Apr. 26	May 14–June 7	July 4	July 4	Aug. 15	Sept. 20	May 29	July 10	Sept. 23	Apr. 23	Sept. 5	Sept. 23	Apr. 19	Sept. 11	—	May 20	—	Sept. 17
	Wright[2]	Apr. 26	—	July 4	—	—	—	May 26	—	—	Apr. 26	—	—	Apr. 23	—	—	May 14	—	—
	Wright[3]	—	—	—	—	Aug. 9–15	Sept. 20	—	July 13–22	Sept. 23	—	Aug. 3–Sept. 5	Sept. 23	—	Sept. 5	—	—	—	Sept. 20
1927	Wright	May 15–21	June 20	July 20	July 5	Aug. 9	Sept. 18	June 5	July 25	—	May 15–21	Aug. 29	—	—	Aug. 29–Sept. 3	—	June 15	—	—
	Hinman	May 14	June 4–16	June 28–July 16	July 4	Aug. 18	Sept. 11	June 4	July 31	—	May 5	Aug. 21	—	May 7	Aug. 27	—	June 13	—	Aug. 18
	Broadway	—	—	—	—	Aug. 5–9	Sept. 10	—	Aug. 1	—	—	Aug. 19	Sept. 10	—	Aug. 23–29	—	—	—	—
1928	Haueter[4]	—	—	—	—	July 28–Aug. 19	—	—	July 26	—	—	—	—	—	—	—	—	—	—
	Haueter[5]	—	—	—	—	July 28	—	—	July 26	Sept. 8	—	—	—	—	—	—	—	—	—
	Haueter[6]	—	—	—	—	July 28–Aug. 19	—	—	July 28	Sept. 6	—	—	—	—	—	—	—	—	—

[1]Apple-ferment block operated continuously throughout the season.
[2]Observations from 11 separate sets of experiments running through parts of the spring brood only.
[3]Observations from 2 experiments running throughout the late broods only.
[4]Observations from the whole series of experiments running through the late broods after July 24.
[5]and [6]Observations from check rows, consisting of baits operated without change of kind of material.

THE "SPITTING" HABIT OF LEPIDOPTEROUS LARVAE[1]

By HERBERT J. PACK[2]

ABSTRACT

Certain Lepidopterous larvae including *Zophodia grossulariae* Riley, *Anarsia lineatella* Zeller, *Spilonota ocellana* (D. and S.) and *Recurvaria nanella* Busck were found invariably to reject the first mouthfuls of food when entering the host plants. *Hulstea undulatella* Clemens, *Autographa californica* (Speyer), and a species of *Loxostege*, all of which differ from the above mentioned in being external feeders, did not reject or "spit" food.

Probably too little attention has been given to the feeding habits of very young larvae. Smith (1926) called attention to the interesting and regular habit of the newly hatched larvae of the codling moth, *Carpocapsa pomonella* (Linn.), of rejecting the first mouthfuls of food in effecting their initial entrance into the apple. Several earlier workers including Card (1897), Slingerland (1898), Siegler and Plank (1921) had noted the habit, but, as Smith remarks, "its significance has been almost entirely overlooked ———." Peterson (1929) working with the oriental peach moth, *Laspeyresia molesta* Busck, reports that the young larvae of that insect have a similar habit. He says, "the first mouthfuls are not consumed, but are set to one side. After the larva has its head deeply buried in the gouged out cavity it starts to feed."

During the past summer while detailed life history observations of the gooseberry fruit worm, *Zophodia grossulariae* Riley, were in progress, it was noted that not only the newly hatched individuals, but larvae of all instars rejected food when entering the fruit.

The newly hatched larva crawls around for a length of time varying a great deal in different individuals and finally begins to eat into the fruit. The first mouthfuls are cast aside. Frequently the larva carries the rejected material some distance from the point of entrance before casting it away. Later as it tunnels farther into the berry it backs out and casts the food just outside the hole. During the whole process until the body has disappeared entirely the larva, so far as could be observed, ate none of the food. Later, larvae removed from berries in which they had been feeding and placed on new fruit repeated the "spitting" process. Whenever a larva of any instar, naturally dislodged or mechanically removed from the insde of a berry, attempted to gain entrance into another fruit it rejected the first mouthfuls. This practice was observed

[1]Contribution from Department of Entomology, Utah Agricultural Experiment Station.

[2]Entomologist. Publication authorized by Director, 15 December, 1929.

NOTE: Dr. H. J. Pack died suddenly on January 5, 1930.

in numerous larvae of all instars except the last. Here only one observation was made, but the practice was unaltered. The method related above was followed regardless of the length of time which the insects had been feeding previously. Some of the older larvae began to retain food, however, when only the head had disappeared within the fruit, although, as a rule the greater part of the first half of the body was buried in the fruit before the rejection of food ceased.

Observations of the larvae of the bud moth, *Spilonota ocellana* (D. and S.), revealed the fact that here too the "spitting" habit was practiced. Observations of this insect covered only the newly hatched larvae. Pieces of the surface leaf tissue are removed and cast aside. Rather soon the larva begins to spin a fragile covering over its body encompassing the spot from which the leaf surface has been removed and not until it is amply covered does it begin to retain the food.

The newly hatched larvae of *Recurvaria nanella* Busck eat and spin alternately and reject all food until they have acquired protection within the mine in the leaf. Once this insect gains entrance it remains within the leaf until it abandons its mining habit in the fall and migrates to the wood to make its hibernaculum. In the spring the larva becomes a leaf feeder and observations to determine whether or not it then "spits" its food have not been made.

Observations of the peach twig borer, *Anarsia lineatella* Zeller, were confined almost entirely to the newly hatched larvae, which begin to eat either into the twig or fruit. Most of the observations were of insects entering the twigs. The little larvae work very rapidly and within from five to fifteen minutes have become completely buried in the twig. Invariably in the insects observed the first food was cast out and not until a good part of the body was hidden did the rejection of food cease. Later larvae, when removed from the burrows and placed on fruit sought the stem end or an abrasion, nibbled at the fruit and then cast it aside. No specimen was watched during the entire course of its entrance into a fruit.

The following insects were observed *not* to eject food: *Hulstea undulatella* Clemens, the sugar beet crown borer; *Autographa californica* (Speyer), the alfalfa semi-looper; and a species of *Loxostege*. The first, i.e. the crown borer, when feeding on the leaf and in every instance where its early activities were carried on and observed above the ground, spun over itself a fine covering before beginning to feed to any extent.

It will be noted that all of these observations apply to Lepidopterous larvae. In all cases in which "spitting" was observed the larvae characteristically feed within the host plant or in a sheltering cover. The larvae

which did not reject food feed upon the exterior of the plant except in the case of the sugar beet crown borer which feeds upon the root or leaf from a silken tube which is buried beneath the soil or is on the surface and covered with soil particles.

The full significance of this practice of food rejection or "spitting" can be measured adequately only when the observations cover an increased number of insects. The economic importance of the characteristic as practiced by the observed insects is apparent when the insecticide used is a stomach poison. Obviously the efficacy of the spray is reduced if insects "spit" most of the poisonous outer covering. Quantitative tests to determine just how much poison is ingested even though most of the food is expelled will no doubt result in considerable progress in the problem of control.

Literature Cited

CARD, F. W. 1897. Observations on the codling moth. Nebraska Agr. Exp. Sta. Bul. 51:1–50.

PETERSON, ALVAH. 1929. Some factors that limit artificial control efforts for the oriental peach moth, *Laspeyresia molesta* Busck. Jour. Econ. Ent. 22:108–115.

SIEGLER, E. H. and PLANK, H. K. 1921. Life history of the codling moth in the Grand Valley of Colorado. U.S.D.A. Bul. 938:1–117.

SLINGERLAND, M. V. 1898. The codling moth. New York Agr. Exp. Sta. Cornell Bul. 142:1–69.

SMITH, RALPH H. 1926. The efficacy of lead arsenate in controlling the codling moth. Hilgardia 1:403–453.

ADDITIONAL NOTES ON *APHIS POMI* DE G.

By C. R. CUTRIGHT, *Ohio Agricultural Experiment Station, Wooster, Ohio*

ABSTRACT

Growing terminals are at least four times as attractive as the non-growing and the aphids located on such produced almost six times as many young.

During a period of several years which has been devoted to research work with *Aphis pomi*, the writer has become much interested in the food conditions that favor this species. The fact that this aphis must have food that is actively growing before it can increase to great numbers has been pointed out by Baker and Turner (1), Lathrop (5), Cutright (3), and Garman (4). These observations have dealt with the species after establishment on terminals and have not considered the reaction that takes place when migrants are locating new food. To test this reaction a given number of twigs were selected, half of which were actively growing while the other half had ceased growth. On each of these twigs there were then placed 6 migrants taken from old colonies.

Four experiments of this nature were conducted and the results are shown in Table 1.

TABLE 1. PERCENT OF MIGRANTS REMAINING ON GROWING AND NON-GROWING TERMINALS AT THE END OF 48 HRS.

	Growing terminals	Non-growing terminals
Experiment 1	33%	12%
Experiment 2	50%	4%
Experiment 3	22%	12%
Experiment 4	8%	0%
Average	28.2%	7.5%

These results with significant odds of 27.5–1 lead us to conclude that the growing terminals were at least four times as attractive to the migrants placed on them as were the non-growing. In the field even more conclusive data has been collected. For example, on the 22nd of July, 1929 when about four-fifths of all terminals had hardened, in a count including 562 terminals, not a single hardened terminal was tenanted by migrants while the actively growing terminals were over 10 per cent infested. Such data has been duplicated many times in the past few years.

The next question that arises is, what effect will food have on the reproduction of migrants after they have selected a feeding place? In conducting the experiments summarized in Table 1, data were taken on this point and this is given in Table 2.

TABLE 2. REPRODUCTION PER INDIVIDUAL MIGRANT ON GROWING AND NON-GROWING TERMINALS

	Growing Terminals	Non-growing terminals
Experiment 1	6.0	.7
Experiment 2	3.3	1.0
Experiment 3	5.4	3.0
Experiment 4	11.0	.0
Average	6.4	1.2

This data with odds of 72–1 shows that the individual migrant located on a growing terminal produces almost 6 times as many young as does one located on a terminal that has ceased growth. Such a difference is indeed significant when the factors governing outbreaks are to be considered. As in the first case, field observations fully confirm the above figures.

Once located on a terminal the amount of reproduction that follows can be correlated directly with the amount of growth that the terminal

makes. This is shown clearly by the following experiment. On June 3, 1929, five migrants were placed on a growing terminal of each of six young potted apple trees that were held under wire screen. The following day the migrants were removed and ten newly born aphids were left on each terminal. At the end of 31 days the terminal growth was measured and the number of aphids on it counted. In all instances some aphids had migrated to other terminals and these together with the growth of the terminal are included in the figures in Table 3.

TABLE 3. AMOUNT OF TERMINAL GROWTH AND NUMBER OF INDIVIDUALS PRODUCED FROM A GIVEN ORIGINAL NUMBER OF APHIDS

Tree	Centimeters growth	No. of aphids	
1	5.5	322	
2	6.0	368	
3	7.2	460	Odds above
4	9.6	621	2221–1
5	20.8	1150	
6	25.1	1181	

When the factors of vegetative growth and aphid reproduction are correlated, the remarkably high measure of association or correlation coefficient of .9703 is the result. Significant odds of 2221–1 may be calculated from this coefficient. In the field, luxuriously growing terminals are frequently noted where the aphid population numbers between 2,000 and 4,000. Close by are less vigorous terminals where the population will number only a few hundred. In view of the above figures there is little doubt that these populations came from about the same original numbers and that the great difference in final population is due to difference in food.

A further interesting fact regarding the effect of food on aphids already established on hardened foliage has been noted. About mid July some terminals on potted trees hardened, the foliage being infested with apterous *pomi*. From this time, unless attacked by predators, this population maintained itself almost intact till early September and some individuals lived even longer. During this period of almost eight weeks, covering high temperature intervals of July and August, such aphids seemingly did not grow and certainly did not reproduce. We have no experiments to confirm this idea but there is little doubt that such individuals if provided with suitable food would grow and reproduce. Therefore, this population, the condition of which certainly resembled that of aestivation, may be the source of infestation of water sprouts in late August and September.

All data included in this paper has a decided economic trend, in that growth condition as it exists in the orchard, particularly after mid July,

may be used with confidence as a basis for predicting the future course of an outbreak of green apple aphis.

Bibliography

Baker, A. C. and Turner, W. F. 1916. Morphology and Biology of the Green Apple Aphis. Jr. Agr. Res., Vol. 5, p. 955–993.

Cutright, C. R. 1928. The Green Apple Aphis. Proc. the Ohio State Hort. Soc., pp. 106–114.

Cutright, C. R. and Huber, L. L. 1928. Growth Condition of the Host as a Factor in Insect Abundance. Annals. Ent. Soc. of America, Vol. XXI, pp. 147–153.

Garman, Philip. 1927. Weather Conditions Accompanying the Aphid Outbreak in Connecticut in 1927. 27th Rpt. State Entomologist of Conn., p. 271–276.

Lathrop, F. H. 1923. The Influence of Temperature and Evaporation upon the Development of *Aphis pomi*. DeG. Jr. Agr. Research, Vol. 23, p. 969–987.

Lathrop, F. H. 1928. Biology of Apple Aphids. Ohio Jr. of Science, Vol. 28, pp. 177–204.

THE INFLUENCE OF RESISTANT APPLE SCIONS ON THE SUSCEPTIBILITY OF NON-RESISTANT STOCKS WITH RELATION TO WOOLLY APHID ATTACKS[1]

By C. L. Fluke, *University of Wisconsin*

Abstract

Northern spy has long been known as an apple variety fairly free from woolly aphid attack. The problem was to determine the influence this variety had on susceptible stock when used as a top graft or as an intermediate scion. The results of this study show that there is very little if any positive influence.

The woolly aphid of apple is a constant pest of apples. It attacks both the parts above ground and the roots but does its most damage to the roots. Excrescences or galls are formed on the roots which interfere with the development of the trees, usually causing stunted trees which produce small and inferior fruit.

Le Pelley,[2] studying the resistance of apple to the woolly aphid, concluded that there is no definite results in favour of the belief that there is an interaction between stock and scion with respect to woolly aphid resistance. He indicated the probability that if there is influence in this respect it is slight. The tests reported here confirm these conclusions.

Method of Procedure. Young trees with various combinations of stock and scion were planted in large pots and then placed in the green-

[1]This problem was suggested by Dr. R. H. Roberts of the Horticultural department of the University of Wisconsin.

[2]R. Le Pelley, Studies on the resistance of apple to the woolly aphis (Eriosoma lanigerum H.). Jour. Pomol. and Hort. Sci. *6* (1927) No. 3, pp. 209–241. pl. 1. **Bibliog.**

house. To secure infestations infested trees were tied to the test trees or only placed near them. In both cases the test trees were readily infested with the aphids.

The following diagram illustrates the combinations used in the tests.

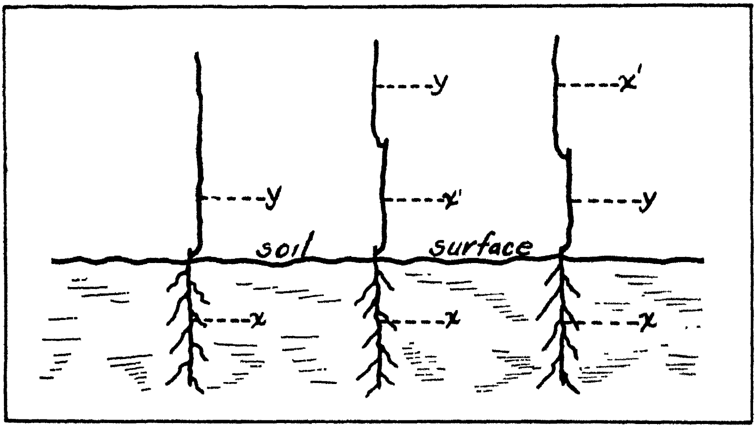


Fig. 66.—Diagram illustrating root and scion combinations. x = susceptible root stock, y = resistant scion, x' = susceptible scion.

In the above diagram x was always a susceptible root stock, either seedling or malling stocks; x^1 was a susceptible scion; Wagner, Wealthy, Hyslop, and Winesap; y was a resistant scion; Spy or Whitney. Thus, will y interact with either x or x^1 so that they will become resistant to aphid attack?

Whitney is classed as semi-resistant as it did not support aphid colonies readily; although in time colonies appeared at the buds but never became as numerous or large as in the purely non-resistant strains. Northern Spy was not entirely free from attack.

Results. The following table gives the results of these tests and shows clearly that the use of a resistant scion such as Northern Spy does not affect the susceptibility of the root stock to aphid attack. Nothing would then be gained by using a resistant variety as an intermediate scion to produce resistance to woolly aphids either in the scion above it or the root stock below.

Large aphid colonies were produced upon all the susceptible roots and scions; only Spy and Whitney to a limited extent, were free from infestations. The susceptible stocks and scions supported just as large colonies of woolly aphids when combined with Spy or Whitney as when used alone, as in test numbers 5, 12, 15, 16, and 17. Unfortunately no trees were available with Spy as an intermediate scion.

TABLE OF RESULTS OF WOOLLY APHID STUDIES

Test No.	Date Started	Date of Results	Scion and Stock Combination	Results
1	Oct. 16	Oct. 30	Root-malling No. 1, top-spy	Large colony on roots, a few small colonies on spy
2	"	Nov. 20	Root-seedling, top-spy	Extremely large colony on the roots, no colonies on spy
3	"	"	Root-seedling, top-Whitney	Rather large colony on roots, a few small colonies on top
4	"	Oct. 30	Root-malling No. 1, top-Whitney	One large colony on roots, 6 small ones on Whitney
5	"	"	Malling No. 1—root and top	3 trees and all were almost completely covered with aphids
6	Oct. 30	Nov. 20	Root-seeding, top-spy	Several large colonies on roots, only one small colony on spy
7	"	"	Root-seeding; top-Whitney	Large colonies on roots amd considerable on the top. This tree later died
8	"	"	Root-seeding; top-Whitney	Large colonies on roots and branch from roots, top with only small colonies at the buds
9	"	"	Root-malling No. 1, top-spy	2 trees—roots with several large colonies, only a few small ones on the spy
10	Oct. 31	"	Root-malling No. 1, mid section—Whitney-, top-winesap	Small colonies on all sections, larger colonies later developed on the winesap and malling
11	Nov. 20	Dec. 13	Root-malling No. 1, mid section-Whitney, top-winesap	Top with large colonies, mid section with a small colony, root with one large colony
12	Nov. 2	Nov. 20	Root-seedling, mid section-malling No. 1, top-wagner	Numerous small colonies on roots, mid section, and top
13	Nov. 3	Dec. 13	Root-seedling, mid section-hyslop, top-Whitney	Colonies large and well scattered on hyslop, very few on Whitney, heavy on the roots. 2 trees
14	Nov. 20	Dec. 13	Root-seedling, top-Whitney	Large colony on roots, small ones on Whitney
15	"	Jan. 8	Root-seedling, top-malling No. 1	Numerous colonies on both seedling roots and malling top. 2 trees
16	"	Dec. 13	Root-malling No. 1, top-seedling	Large colony on malling roots, one large and two small colonies on seedling top
17	Dec. 13	Dec. 28	Root-seedling, top-seedling	10 trees, all heavily infested, all died within two months

THE MITE, *LINOPODES ANTENNAEPES* BANKS, AS A PEST OF CULTIVATED MUSHROOMS, WITH PRELIMINARY TESTS TOWARD CONTROL

By O. E. Gahm, *U. S. Bureau of Entomology*

Abstract

The mite *Linopodes antennaepes*, heretofore unrecorded as a pest of mushrooms, was first found attacking cultivated mushrooms in Pennsylvania during March, 1929. The mite was found later in the year causing commercial damage in ranges of mushroom houses at Ashtabula, Ohio, and Naperville, Illinois and in one of the sandstone caves at St. Paul, Minnesota.

The injury produced by this mite is characterized by a partial destruction of the "root system" and a decided constriction of the sporophore at the base. Thermal-death-point experiments show that the mites can not withstand a temperature of 100.4°F., for a half hour exposure in a constant temperature chamber with an accompanying relative humidity of 89 per cent.

Control by steaming the surface of the compost heap was practiced with good results.

During March, 1929, while inspecting mushroom houses in Pennsylvania, the writer found a mite causing commercial damage in a house near Kennett Square. This mite has been determined by Dr. H. E. Ewing of the Bureau of Entomology, as *Linopodes antennaepes* Banks.

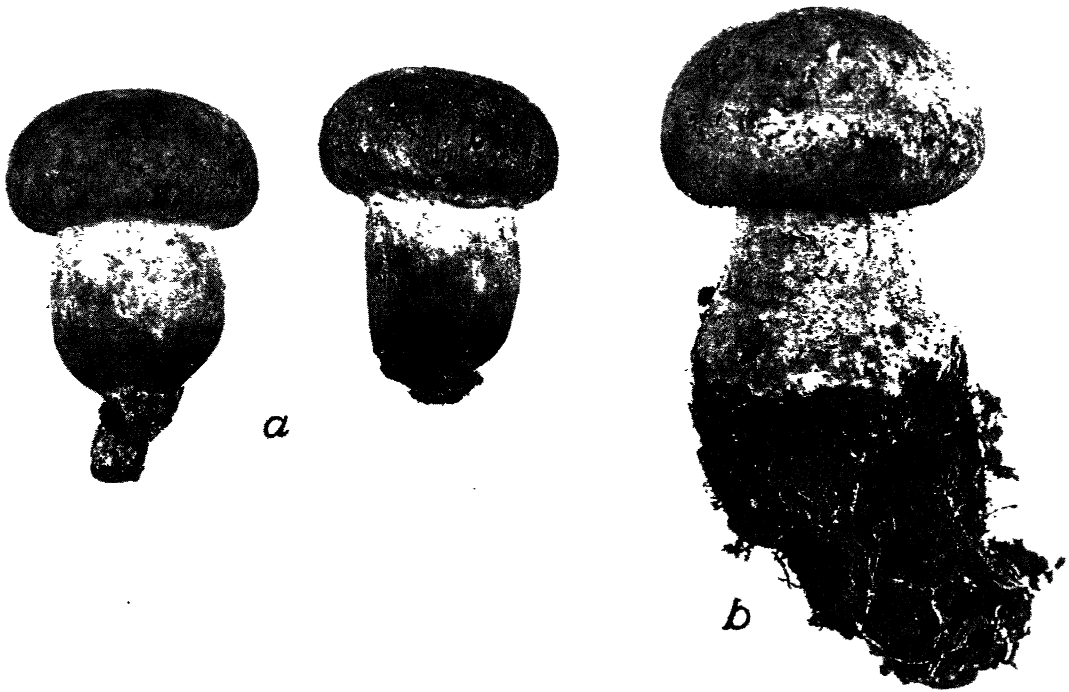
Later in the year it was again discovered causing like damage in ranges of mushroom houses at Ashtabula, Ohio, and Naperville, Illinois, and in one of the sandstone caves at St. Paul, Minnesota.

Dr. Ewing reports that he does not have any record of this mite being taken in mushroom houses and a review of the literature does not show that it has heretofore been recorded as a pest of mushrooms or found on wild fungi.

Taxonomy.—According to Banks[1] this mite belongs to the family Eupodidae, and to the subfamily Eupodinae, which is characterized by the presence of two suckers on each side of the genital aperture, the absence of submedian sensory hairs on the cephalothorax, and indistinct segmentation of the abdomen. Mites of the genus *Linopodes* are characterized by having extremely slender legs (the front pair being much more than twice as long as the body) and hind femora somewhat thickened.

Banks describes the adult mite as being pale yellowish or reddish in color, some having white marks; one on the back in the form of a "T." The first pair of legs, which are more than twice the length of its body, are used as feelers and when the mite is disturbed it runs very rapidly.

[1]Banks, Nathan, 1915. The Acarina or mites. U. S. Dept. Agr., Report, Office of Secretary No. 108.



a, Mushrooms injured by *Linopodes antennaepes*; *b*, a normal mushroom.

Banks says, "It is common on the ground under pieces of wood, bark, etc., that have lain there some time."

NATURE OF ITS INJURY TO MUSHROOMS.—The injury resulting from the attack, of this mite on the cultivated mushroom, *Agaricus campestris*, is rather unusual. Its feeding on the "root system" causes the mushroom stalk or stipe to become very much constricted at the base. The lower half of the stipe is often discolored, the color ranging from pinkish to brown. In severe cases of damage the sporophore is held to the surface of the bed by only a few withered filaments. The injury is clearly shown in the accompanying photograph. The result of the injury from this pest under heavy infestations is a decided reduction in crop yield as the injured mushrooms do not develop to a normal marketable size. However, these small mushrooms if not too badly discolored are suitable for canning. Even though they may be disposed of for such purpose they do not bring as high a price as normal mushrooms.

A large grower in Ohio having over 325,000 square feet of mushroom bed space estimated his loss for the season from this pest to be approximately 40 per cent of the total crop or ¾ pound per square foot.

Since the habits of the mite have been under observation for only a short time, little is known as to the effect of its attacks on the mycelium. Thus far, the chief point of attack seems to be the base of the stalk after the mushroom appears above the surface of the bed. Under heavy infestations many of the mushrooms are completely covered with these mites. The fact that this species is capable of moving rapidly makes this pest all the more dangerous, since it can migrate from one bed to another much more quickly than the mushroom mite, *Tyroglyphus lintneri* (Osb.) which moves slowly.

PRELIMINARY CONTROL MEASURES.—Since the mushroom houses in Ohio where this pest was so abundant had at one time been infested with the mushroom mite, *Tyroglyphus lintneri* (Osb.), and controlled by surface steaming of the compost before it was taken into the houses the grower resorted to the same control measure. In order to ascertain the most exact and effective procedure to follow in these treatments with steam, in regard to penetration of the steam into the compost and the duration of the treatment necessary for control, the thermal death point of the mite and the temperature of the compost heap at various depths were determined. Through the courtesy of the Department of Botany of the University of Minnesota, the writer was enabled to conduct the experiments on the thermal death point of this pest in the constant-temperature chambers at that institution. From 15 to 20 adult mites were

subjected to the range of temperatures shown in Table 1, being placed in straight sided jars 2½ inches in diameter and 5½ inches tall, which were filled with composted manure and covered with fine cheese cloth.

The relative humidity in the constant-temperature chambers was maintained at about 89 per cent. Results of preliminary experiments showed that the mites congregated in the center of the compost in the jars when subjected to heat, therefore a thermometer was inserted in the center of the compost in each jar in order to obtain the temperature within the compost after a given exposure.

TABLE 1. EXPERIMENTS TO DETERMINE THE THERMAL DEATH POINT OF THE MITE *Linopodes antennaepes* IN COMPOSTED MANURE IN CONSTANT-TEMPERATURE CHAMBERS IN WHICH THE RELATIVE HUMIDITY WAS MAINTAINED AT ABOUT 89 PER CENT

Temperature of chamber		Period of exposure	Average temperature of compost on removal		Number of experiments	Results
°C.	°F.	Hour	°C.	°F.		
60	140.0	¼	53.0	127.4	3	All killed
		½	58.5	136.8	2	Do.
55	131.0	¼	48.0	118.4	3	Do.
		½	53.5	127.8	2	Do.
52	125.6	¼	47.5	117.0	2	Do.
		½	50.5	122.4	2	Do.
49	120.2	¼	42.5	108.0	2	Do.
		½	47.5	117.0	2	Do.
		¼	40.0	104.0	1	Do.
45	113.0	½	44.0	111.2	1	Do.
		¾	45.0	113.0	1	Do.
38	100.4	¼	37.5	99.0	2	A few active
		½	38.0	100.4	2	All killed

From the foregoing data it is deduced that adults of this pest can be killed when subjected to a temperature range of 40° C. to 53° C. for one-fourth hour. At 38° C. it appears necessary to expose the mites for one-half hour.

Upon comparison of these data with the results of the readings given in Table 2, made on a 300-ton manure heap at the Ohio plant, it is seen

TABLE 2. AVERAGE TEMPERATURES ON TOP, ON SIDE 1 FOOT FROM TOP, AND ON SIDE 1 FOOT FROM BOTTOM OF A 300-TON COMPOST HEAP, AT VARIOUS DEPTHS BEFORE STEAMING

Depth	Temperature on top (Average of six readings)	Temperature on side 1 foot from top (Average of three readings	Temperature on side 1 foot from bottom (Average of three readings)
	°F.	°F.	°F.
Two inches....	110	96	98
Four inches....	137	104	109
Six inches.....	158	121	125
Ten inches....	158	134	142

that the temperature below a depth of 4 inches in the manure heap is too high for the survival of the mite. Therefore it is not necessary to penetrate the compost with steam beyond that depth.

Temperature readings taken immediately after steam at 200° F. from a 2 inch outlet had passed over the surface of the compost heap showed that at a depth of 2 inches the temperature was 152° F. and at 4 inches 132° F. No live mites were found in samples of the treated compost taken at various depths.

Comparing these data with the thermal death point readings it appears as if the steam-treatment process as practiced is adequate to rid compost of these mites.

The foregoing conclusions are further substantiated by the fact that no mite infestation had developed, when last observations were made in the houses where this compost was used.

In view of the fact that very few mushroom plants are provided with the necessary equipment for surface steaming of the compost heap, other measures of control, which will be practical for the average grower, must be worked out in case the appearance of this pest becomes general.

THE LATIN SQUARE ARRANGEMENT OF EXPERIMENTAL PLATS

By F. Z. HARTZELL, *New York State Agricultural Experiment Station, Geneva, N. Y.*

ABSTRACT

Variation in infestation vitiates conclusions drawn from field tests unless the plat technique is able to compensate for such heterogeneity. The Latin Square arrangement of test plats proposed by Fisher has a number of advantages over the ordinary method of using strips across the area. The Latin Square is applicable to areas in which the variation from plat to plat occurs by approximately constant differences. It does not always compensate for heterogeneity when differences occur by chance or in approximately geometrical series. Careful studies of proposed test areas should be made to determine the type of variation present and no tests made except in those places in which a high degree of accuracy can be secured.

When an investigator makes a field experiment he usually aims to compare either the yields of certain varieties of the same crop or the effects of different treatments upon a certain variety. Since all the tests must be conducted during the same period of time, obviously, he must make the tests on different plats; so usually he selects what appears to be a very uniform area and divides this into the desired number of small blocks on which the several comparisons are to be made. If the number of plats equals the number of treatments (i.e., if there are to be no replications in treatment) he tacitly assumes that if all were treated uniformly the

yield per acre would be practically the same on every plat. The more careful experimenters have recognized the fact that the yields from a series of apparently uniform plats are not identical. For simplicity all comparisons in this paper will be yields. The application of the same ideas to insect infestation will be obvious to the reader.

Of the various arrangements proposed to overcome heterogeniety, the Latin Square of R. A. Fisher (1)[1] seems the best discovered for eliminating bias in field tests. The basic principle of this system is that there be an equal number of plats from left to right (rows) and from front to back (columns), and that each row and each column shall contain a complete series of the tests with no replications. This will be clear from a study of Chart 1 in which each plat that is to receive the same treatment is designated by a certain letter.

FORMATION AND DISCUSSION OF THE LATIN SQUARE CHESSBOARD. Fisher proposed that the selection of treatment for the plats be by lot. Suppose four treatments are to be compared. This necessitates four replications for each treatment. On a sheet of paper draw a large square, divided into 16 smaller squares, which forms a 4 x 4 chessboard. Now take four small cards of equal size and mark each with a single letter as follows: A, B, C, and D. These are placed in a bag or other opaque receptacle, thoroly mixed and a card picked out at random. Suppose the first card drawn bears the letter C, the second D, the third B, and the fourth A. Mark the upper left square of the chessboard C, the next square to the right with a D, the third square B, and the last square A. (Chart 1) Repeat the operation for the next row below. Suppose the first card is marked D and the second C. These are placed in their respective squares. A and B remain for the second row, but in order that two plats having identical treatment should not appear in the same row or column, it is necessary to mark the third square A and the fourth B. The cards are again mixed in the receptacle and a drawing made. Suppose B is on the next card. Mark the left square of the third row B. The second square must be marked A, otherwise the rule regarding replications in rows or columns would be violated. The third square can be either C or D and the drawing reveals it to be C, so the fourth square must be D. There is no choice regarding the fourth row which must be A, B, D and C respectively.

C	D	B	A
D	C	A	B
B	A	C	D
A	B	D	C

Chart 1. Plot Treatments Selected by Lot

If Chart 1 be considered a plane, it will be noted that the center of gravity of any four identical plats (e.g. the B's) is the center of the plane. In

[1]Numbers in text refer to literature cited at end of paper.

other words, the plats are balanced because the sum of their moments of inertia is zero. *If previous to treatment the variation from plat to plat is uniform, i.e., if the changes thruout the area consist of constant differences* the mean of each set of plats (the "set mean") will be identical with the mean of the sixteen plats (the "general mean"). Therefore, if after treatment, the mean of any set differs significantly from the mean of another set, it can be attributed to the treatment, not to *place variation.*

The shape of the plats makes no difference provided all are the same shape and size. This is an important consideration because in field tests usually rectangular blocks are more practical than square ones. This is especially true for spraying tests in orchards where the rectangular plat requires less turning of the team and rig for the same number of trees than does a square one.

During the past four years the writer has used the arrangement shown in Charts 2–7 (for both rectangular and square areas) instead of selecting by lot. Of course this is one of the possible chance arrangements, but it has several advantages, the chief of which are: (1) That with rectangular areas, for every treatment, two plats adjoin lengthwise two plats of every other treatment. This enables the investigator to compare treatments carefully, and to detect certain differences that might otherwise escape notice. From the viewpoint of the station worker this is very important because it assists visitors to make comparisons, since frequently experimental plats serve as demonstrations of the several treatments. This is especially true with long term tests. (2) When a number of chessboards are in use there is less danger of becoming confused in placing the applications on the correct plats than if all chessboards are different. Anyone who has attempted large scale orchard experimentation with insecticides can appreciate how easily confusion may arise.[2]

The properties of the Latin square, so far as they relate to means, will be illustrated by the charts. Those workers who desire to study the properties relating to probable errors or standard errors are referred to Fisher (1) and Student (2).

ADAPTABILITY OF THE LATIN SQUARE TO CERTAIN TYPES OF VARIATION. In Charts 2 to 5 are shown theoretical yields on 4 x 4 chessboards. The

[2]The following arrangement, lately devised by the writer, where the "border effect" is important may be preferable. However, care must be exercised in arranging the plats in order to have each treatment adjoin every other treatment lengthwise twice. It will be noted that this condition does not hold endwise for the treatments as it does in charts 2–7.

A	B	C	D
D	C	A	B
C	D	B	A
B	A	D	C

Charts Showing Variation with Constant Differences

Chart 2. Diagonal Variation

					Strip means
	A 40	B 50	C 60	D 70	55
	B 50	D 60	A 70	C 80	65
	C 60	A 70	D 80	B 90	75
	D 70	C 80	B 90	A 100	85
Strip means	55	65	75	85	Gen. mean 70

Set means
A's = 40+70+70+100 = 70
B's = 50+50+90+ 90 = 70
C's = 60+80+60+ 80 = 70
D's = 70+60+80+ 70 = 70

Chart 3. Peaked and Skew Variation

					Strip means
	A 70	B 80	C 70	D 60	70
	B 80	D 90	A 80	C 70	80
	C 70	A 80	D 70	B 60	70
	D 60	C 70	B 60	A 50	60
Strip means	70	80	70	60	Gen. mean 70

Set means
A's = 70+80+80+50 = 70
B's = 80+80+60+60 = 70
C's = 70+70+70+70 = 70
D's = 60+90+70+60 = 70

Chart 4. Asymetrical Inclined Trough Variation

					Strip means
	A 100	B 90	C 80	D 90	90
	B 90	D 80	A 70	C 80	80
	C 80	A 70	D 60	B 70	70
	D 70	C 60	B 50	A 60	60
Strip means	85	75	65	75	Gen. mean 75

Set means
A's = 100+70+70+60 = 75
B's = 90+90+70+50 = 75
C's = 80+80+80+60 = 75
D's = 90+80+60+70 = 75

Chart 5. Asymetrical Concave Variation

					Strip means
	A 90	B 80	C 70	D 80	80
	B 80	D 70	A 60	C 70	70
	C 70	A 60	D 50	B 60	60
	D 80	C 70	B 60	A 70	70
Strip means	80	70	60	70	Gen. mean 70

Set means
A's = 90+60+60+70 = 70
B's = 80+80+60+60 = 70
C's = 70+70+70+70 = 70
D's = 80+70+50+80 = 70

areas represent conditions existing when all plats are planted to the same variety and are under uniform treatment, the object being to show which types of variation are suitable for field tests either with different varieties or the same variety under different treatments. For simplicity of reference, let each chart be considered a map with the top representing north.

A simple arrangement of plats is in strips. With this method, obviously the strip yields would not be identical unless there were no variations or unless the variations were strictly parallel with the strips. In Charts 2–7 each strip contains four plats. The mean of each set of plats ("strip mean") can be compared with the general mean of the plats, but most important is the ability to determine the direction of variation in yield across the area. The strip means for rows and columns will be given in all the charts for comparison with each other and with the general mean. Also, the set means can be compared with the general mean in each chart.

The criterion of accuracy is the amount of difference between parallel strip means, also between the general mean and the set means. Obviously, the smaller these differences, the more accurate is the arrangement.

An examination of Charts 2–5 shows that so long as the variation from plat to plat occurs by equal differences, the Latin Square will cause the set means to be identical with the general mean regardless of whether the variations occur under the following types: Diagonal, peaked and skew, asymetrical trough or asymetrical concave. However, in none of these cases are the parallel strip means identical regardless of whether the strips run north and south or east and west. For this reason none of these types would be suitable for an experiment in which the strip method is used. Nevertheless, all would be suitable for field tests if the plats followed the Latin Square arrangement.

It will readily be noted that in field tests these types of variation are more probable than variations parallel to the strips, therefore if the Latin Square can be used, more opportunity will be offered for making field tests. In fact, if the strip method is used, in many instances either no tests could be made or the experimenter must use a faulty technique. Entomological examples of the four types of variation in Charts 2 to 5 are as follows:

Diagonal, grape-vine fleabeetle, grape root-worm, grape leafhopper, codling moth, and rose chafer.

Peaked and skew, grape root-worm and codling moth.

Asymetrical Inclined Trough, grape leafhopper, pear psylla, and rosy aphis.

Asymetrical Concave, pear psylla, grape leafhopper, and cutworms.

Chart 6. Hyperbolic Sheet Variation

					Strip means
	A 100	B 100	C 100	D 100	100
	B 69	D 69	A 69	C 69	69
	C 59	A 59	D 59	B 59	59
	D 55	C 55	B 55	A 55	55
Strip means	70.8	70.8	70.8	70.8	70.8

Set means
A's, B's, C's and D's =
100+69+59+55 = 70.8

Chart 7. Diagonal Hyperbolic Variation

					Strip means
	A 100	B 69	C 59	D 55	70.8
	B 69	D 59	A 55	C 54	59.3
	C 59	A 55	D 54	B 53	55.3
	D 55	C 54	B 55	A 53	53.8
Strip means	70.8	59.3	55.3	53.8	Gen. mean 59.8

Set means
A's = 100+55+55+53 = 65.8
B's = 69+69+53+53 = 61.0
C's = 59+54+59+54 = 56.5
D's = 55+59+54+55 = 55.8

Types of Variation in Which the Latin Square Gives Small Gain in Accuracy. In Charts 6 and 7 are shown types of variation where the differences between plats in one or more directions are in approximately geometrical progression.

In the hyperbolic sheet type the variation extends parallel with the strips running north and south. The means of the north and south strips are identical, while the means of the east and west strips are not. It will be noted that in this type there is no advantage in using the Latin Square arrangement, at least so far as the means are concerned. In the Diagonal Hyperbolic type neither series of strip means are identical, and furthermore, the set means are not identical with the general mean. Altho there is a slight increase in accuracy by the use of the Latin Square, the discrepancies are too large to consider this type as suitable for field tests.

Entomologically, the finest examples of these two types in nature observed by the writer are furnished by the grape-berry moth. In western New York these are the usual forms of distribution of this insect.

Conclusions. The Latin Square or chessboard arrangement of field plats offers a method that generally greatly improves the accuracy of the test over the strip arrangement provided the plat differences are approximately equal. By employing the Latin Square, frequently areas can be

used for field tests that would be very inaccurate by the strip method. Where plat differences occur more or less in geometrical proportion, the Latin Square adds practically nothing in accuracy over the strip arrangement. Such areas are suitable for field tests only when the variation is strictly parallel with the strips (Hyperbolic sheet). It follows that the investigator must not look upon the Latin Square as a fetish that will drive away all the evil spirits coupled with variation in field tests. He should first make careful observations supported by as much numerical data as practicable before laying out a series of field tests, using the Latin Square arrangement, if practicable, with types of variation where accuracy is to be gained and avoiding the use of areas where inaccuracy is bound to affect the results regardless of the plat arrangement.

Literature Cited

1. Fisher, R. A. Statistical Methods for Research Workers, 2d Ed. Edinburgh. 1928.
2. "Student." Mathematics and Agronomy, J. Am. Soc. Agron. 18:703–19. 1926.

PETROLEUM OIL SUMMER SPRAYS FOR PINE LEAF SCALE CONTROL (FAMILY COCCIDAE—ORDER HOMOPTERA)

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Abstract

Petroleum oils of the following types were tested in the field during the summer of 1928 for their toxicity to the White Pine Scale, *Chionaspis pinifoliae* (Fitch):—(1) Lubricating oil, (2) Miscible oil, (3) Three grades of highly refined "white oil." The tolerance of the various coniferous foliages to these oils was also determined. Little difference was noticed in the toxicity of the oils (when compared at strengths sufficient for control). An oil concentration of 2.5 per cent was sufficient to give commercial control (90–100%). Highly refined "white oils" (Baume 36.6°–35.4°, Saybolt viscosity 45–85 sec/100° F.) were the only oils which could be applied (at a concentration sufficient for control) without subsequent foliage injury. The conifers tested varied in their susceptibility to oil spray injury in the following order: (1) White Spruce (most susceptible), (2) White Pine, (3) Red Pine and Scotch Pine (least susceptible).

The bloom normally present on conifers disappears when an oil spray is applied. It reappears within 5–10 weeks, depending on weather conditions and the volatility of the oil applied.

The pine leaf scale [*Chionaspis pinifoliae* (Fitch)][1] is an important nursery pest in the North Central States. Since the parasites of this insect

[1]The author wishes to acknowledge with thanks the identification of the insect by Dr. Harold Morrison, Bureau of Entomology, Washington, D. C.

do not appear to be controlling it,[2] there is need for an efficient insecticide which will not only control the scale but will cause no damage to the pine foliage.

Petroleum oil has hitherto been considered one of the most effective insecticides for scale insects. Unrefined lubricating oils, however, are unsafe to apply to trees in foliage, and miscible oils (petroleum oils with a soluble emulsifying agent) appear to be variable in their action. The highly refined "white oils" have recently been found safe to apply to several types of deciduous foliages.[3,4] The "white oils" are produced by treating the crude oil repeatedly with concentrated sulphuric acid.

In these experiments, lubricating oil, miscible oil and highly refined "white oils" have been tested to ascertain their toxicity to the scale and their toleration by coniferous foliage. The experiments are divided into two series:

(1) Toxicity of the oils at various concentrations to the white pine scale.

(2) Tolerance of the various species of conifers for the several types of petroleum oils.

All the sprays were applied during the summer of 1928. Spraying began on May 26 and was continued at intervals until August 8, 1928.

Material and Procedure of the Experiments. A heavily infested group of White and Red Pines 15–20 years old was used for the toxicity experiments. A group of uninfested nursery seedlings of White Pine, Scotch Pine, and White Spruce, (3–5 years old) as well as a group of mature White Spruce and Red Pine, was utilized for the tolerance experiments.

Table 1 gives the specifications of the oils and emulsions of these oils which were tested in the experiments. In the case of commercial products, the emulsions were broken and the specifications determined on the oil base. Viscosity was measured by the Saybolt Universal Viscosimeter at 100° F. The per cent of unsaturateds present was measured by the loss to 38 normal fuming sulphuric acid.[5]

Toxicity Experiments. The sprays were applied at a pressure of approximately 125 pounds per square inch, and the trees were thoroughly

[2]Counts made on 25 thousand scales collected at Ames, Iowa, showed a parasitization of 1.4 per cent. The majority of this 1.4 per cent were parasitized by the hymenopterous parasite, *Perissopterous pulchellus* Howard.

[3](1928) Harman, S. W. "Midsummer Sprays for the Peach Cottony Scale." New York State Agr. Exp. Sta. (Geneva) Bull. 552.

[4](1928) deOng, E. R. "Progress Report on the Use of Petroleum Oil as an Insecticidal Spray." Jour. of Econ. Ent. 21:No. 4, pp. 525–529.

[5]Journal of Official Agricultural Chemists, Washington, 10, No. 1, p. 30 (1927).

wet in all cases. Counts were made of the live and dead scales one month after treatment. A number of infested needles were taken from scattering points over the tree in order to secure a representative sample and tallys were made from these. One thousand or more scales were counted in the majority of the experiments. For the determination of the efficiency of the application, account was taken of the percentage of living scales present in the control trees at the time the count was made. Abbott's method[6] for computing the efficiency of insecticides was used. This is essentially as follows:

Let x = per cent of living on the control trees,
and y = per cent of living on the treated trees.

$$\text{Then } \frac{x-y}{x}(100) = \text{efficiency of the insecticide.}$$

TABLE 1. SPECIFICATIONS OF PETROLEUM OILS AND EMULSIONS

Oil	Specifications of Emulsions: Market Type	Emulsifying Agent	Oil Strength of Stock	Specifications of Oil Base: Viscosity Saybolt/ 100° F.	Baume Reading at 60° F.	Unsulfonated Residue
WHITE OILS						
(1) Light	Commercial	Non-soap	65%	45 seconds	36.6°	98–100%
(2) Medium	Commercial	Non-soap	65%	85 "	35.4°	98–100%
(3) Heavy	Commercial	Non-soap	65%	111 "	31.8°	90– 93%
LUBRICATING OIL	Home-made	Potash fish oil soap	65%	237 "	27.4°	Low
MISCIBLE OIL	Commercial	Oil-soluble soap	Approx. 90%			

The first applications were made at 2.5 and 5 per cent total oil concentrations. In later experiments the strength was lowered to one and two per cent.

Table 2 gives the results of the toxicity experiments. The sprays were not all applied on the same date so that they are not strictly comparable. The results can be considered indicative, however, of the toxicity of the various types of oil.

The majority of the sprays of 2.5 per cent oil strength gave complete control (95 per cent or over). Two per cent strength of the heavier oils appeared to be sufficient. There seems to be little difference in the toxicity of the white oils, lubricating oils, and miscible oils used in these experiments. However, oil sprays at strengths below two per cent total oil vary considerably in their final kill. The heavier oils (i.e. with greater specific gravity) gave the greater kill in this case. One spray applied on

[6](1925) Abbott, W. S. Method for Computing the Effectiveness of an Insecticide. Jour. of Econ. Ent., Vol. 18, No. 2. 265–267.

July 3rd, was followed shortly after the application by a heavy rainstorm. This may account for the low kills produced by sprays applied on that date.

TABLE 2. TOXICITY OF VARIOUS PETROLEUM OILS USED AGAINST THE PINE LEAF SCALE, AMES, IOWA (1928)

Oil	Concentration	Date	Total number of scales counted	Per cent Kill (as computed by Abbott's Method)
Light White Oil				
(Say. Vis. 45/100° F.)	1%	7–3	1050	31%
	2%	7–3	1025	27%
	2.5%	5–26	1226	88%
	2.5%	5–26	820	99%
	5%	5–26	1040	100%
Medium White Oil				
(Say. Vis. 85/100° F.)	1%	7–5	930	49%
	2%	7–5	1094	97%
	2.5%	5–26	1086	99%
	2.5%	5–26	1099	97%
	5%	5–26	1032	100%
Heavy White Oil				
(Say Vis. 111/100° F.)	1%	7–3	952	45%
	2%	7–3	1106	100%
	2%	8–6	1286	100%
	2.5%	6–8	1251	100%
Miscible Oil	2%	7–3	1058	63%
	2.5%	5–26	1021	93%
	2.5%	5–26	833	100%
	5%	5–26	1053	100%
Lubricating Oil				
(Say. Vis. 237/100° F.)				
Boiled Emulsion	1%	7–5	1021	77%
	2%	7–5	1018	100%
	2.5%	6–2	1120	100%
	5%	6–2	1102	100%
Cresylated Emulsion	2.5%	6–2	1643	98%
				Actual Per Cent Dead
Control Counts	—	7–12	715	18.8%
	—	7–18	1080	29.6%
	—	8–6	1223	21.2%

TOLERANCE EXPERIMENTS. In the tolerance experiments, the oil concentrations of the sprays tested were varied from one to four per cent. One set of trees was given only one application; each spray being applied to an individual of each of the four types of conifers. Another set of trees was given two applications of a two per cent spray with an interval of one month between sprays. This last experiment was designed to test for any accumulative effect.

The condition of the tree was followed by periodical examinations until June 1929. The condition noted at that time was considered as the final criterion of the spray. Injury to the tree was judged by the appearance of the 1928 growth: whether the needles had dried up and dropped off or whether they were in a normal healthy condition.

It was found that there was a difference among the various species of conifers in their susceptibility to oil spray injury. They varied in the following order:

(1) White Spruce (most susceptible), (2) White Pine, (3) Scotch Pine and Red Pine (least susceptible).

The results of the experiments in which two applications were made indicate that few oils can be applied twice without subsequent foliage injury. Only the light "white oils" caused no injury. Even though an oil was chemically non-toxic to the foliage, the long physical contact with the resulting interference in the action of respiration and transpiration would certainly cause damage.

Lubricating oils (at 2 per cent oil strength) consistently caused damage from a single application. Miscible oil was inconsistent in its results, at one time causing no injury, at another producing severe damage. Heavy "white oil" (31.8° B., Saybolt viscosity 111 sec. at 100° F.) also caused considerable injury. That this oil was not as highly refined as the other white oils is shown by the lower amount of unsulfonated residue. The light and medium "white oils" caused no foliage injury at two per cent strength. Even at the higher oil strength (4 per cent) only two trees out of the thirteen treated were injured to any perceptible extent. These results indicate that only the light "white oils" (varying up to 85 seconds in Saybolt viscosity at 100° F. and as low as 35.4° Baume) are safe to apply to conifers at a strength which will control the scale.

Most of the foliage injury caused by the various oil sprays did not appear until the following spring. At that time, the growth of the previous year (that is, the needles which were developing at the time the spray was applied) was partially or entirely shed. This growth was replaced during the following summer so that by the next fall, there was no evidence of foliage injury. This type of injury was especially noticeable on Spruce. Other investigators[7] have observed similar effects following the application of oil sprays to spruce.

An abnormal shedding of foliage such as this would seem to have a very serious effect on the growth and health of a spruce tree. Especially

[7](1926) Herrick, G. W. and T. Tanaka. "The Spruce Gall-Aphid." Cornell University Agricultural Experiment Station Bull. 454, p. 15.

would this be the case with young nursery seedlings which are already in a weakened condition as a result of transplantation.

When an oil spray is applied to a conifer, the bloom, which adds so much to its appearance, disappears. It returns within five or ten weeks, depending on the weather conditions and the volatility of the oil.

Thanks are due to both Dr. C. J. Drake and Dr. C. H. Richardson for suggestions and criticisms on this problem.

PHYSICAL AND CHEMICAL PROPERTIES OF COMMERCIAL ARSENICAL INSECTICIDES II. MAGNESIUM ARSENATE

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Abstract

Commercial magnesium arsenate insecticides are prepared by treating magnesium hydroxide suspended in water, or a solution of a magnesium salt, with arsenic acid or an alkali arsenate. The di or trimagnesium arsenate is formed, depending upon the proportion present of the reacting compounds. The reaction products are then heated in an autoclave to a temperature of 165–175° C. under pressure for several hours in order to reduce the water soluble arsenic content to a low value. The product is then filtered, dried and ground to a fine powder.

There are two grades of this product on the market, and a typical chemical and physical analysis of each is given. They both contain a crystalline material of which certain of the optical properties agree with those of the basic arsenate $Mg_3(AsO_4)_2.MgO.YH_2O$ mentioned in the patents. A short review of the published entomological tests with this material is included.

The purpose of this paper is to outline the commercial methods of preparing magnesium arsenate; to give the composition of commercial magnesium arsenate insecticides now on the market, and to refer briefly to the experimental work in pest control carried out by entomologists with these products.

Historical. The use of magnesium arsenate as an insecticide is comparatively recent, although the first patent application (1) for its manufacture was filed in 1918. Since then other patents (2, 3, 4) have been issued for the manufacture of the insecticide. The early manufactured product was considered unsafe for spraying upon foliage, and was little used, but recently an improved product has been coming into more general use. Considerable effort has been made to prepare the insecticide in a form sufficiently safe for tree spraying.

Manufacture of Commercial Magnesium Arsenate Insecticides. The first patented method of making magnesium arsenate as an insecticide is carried out by bringing together magnesium hydroxide (or some magnesium salt) suspended in water and a solution of arsenic acid

or sodium arsenate. The reactions that may take place according to the proportions of the combining compounds are:

$$(1)\ Mg(OH)_2 + H_3AsO_4 = MgHAsO_4 + 2H_2O$$

$$(2)\ 3\ Mg(OH)_2 + 2H_3AsO_4 = Mg_3(AsO_4)_2 + 6H_2O$$

The di-magnesium orthoarsenate is formed in reaction (1), and the tri-magnesium orthoarsenate is formed in reaction (2).

An improved method of manufacture also has been patented (3). The product obtained in the former method of manufacture had a relatively high water soluble arsenic content. The improved method gives a very low water soluble arsenic figure. The process is carried out by running arsenic acid into magnesium hydroxide suspended in water until the desired arsenic content is obtained, then the mixture is heated to 165–175° C. under pressure in an autoclave for several hours. The material, when removed from the autoclave, is allowed to settle, then filtered, dried and ground.

According to patent specifications, the magnesium arsenate is present in one or all of three distinct crystalline forms. This crystalline material may or may not be mixed with an excess of magnesium hydroxide. Of the three forms that have been identified, the one occurs as exceedingly small, rather lens-shaped crystals, having parallel extinction and a negative principal zone, the indices of refraction being $n\alpha = 1.64$ and $n\gamma = 1.66$. The probable formula for this compound is $MgHAsO_4xH_2O$, in which the value for (x) has not been definitely determined.

A second form occurs either as long, needle-shaped crystals; as elongated, pointed-end crystals; or as short, flat prisms, having parallel extinction and a positive principal zone, the indices of refraction being $n\alpha = 1.58$ and $n\gamma = 1.605$. The probable formula for this form is $Mg_3(AsO_4)_2.MgO.YH_2O$, in which the value for (Y) has not yet been determined.

The third form is probably represented by the formula $Mg_3(AsO_4)_2$. $2MgO.2H_2O$. This form occurs as exceedingly small lens-shaped crystals, having parallel extinction and a positive principal zone, the indices of refraction being $n\alpha = 1.566$ and $n\gamma = 1.575$.

Analytical Data. Two samples of commercial magnesium arsenate of recent manufacture were analyzed. The labels on the samples were as follows:

Sample No. 1

Active Ingredient as Tri-magnesium Arsenate [$Mg_3(AsO_4)_2$] not less than 48.80 per cent

Inert Ingredient not more than 51.20 per cent

Total Arsenic as Arsenic Pentoxide (As_2O_5) not less than 32.00 per cent.

Water Soluble Arsenic as Arsenic Pentoxide (As_2O_5) not more than 0.35 per cent.

Sample No. 2

Active Ingredient as Tri-magnesium Arsenate [$Mg_3(AsO_4)_2$] not less than 61.00 per cent

Inert Ingredient not more than 39.00 per cent

Total Arsenic as Arsenic Pentoxide (As_2O_5) not less than 40.00 per cent.

Water Soluble Arsenic as Arsenic Pentoxide (As_2O_5) not more than 0.35 per cent.

The analytical work was carried out according to the A.O.A.C. Methods (Second Edition, Revised to July 1, 1924), and "Standard Methods of Chemical Analysis," by Scott (Second Edition, Revised 1917).

The cubic-inches-per-pound were determined by passing the insecticide through a 30-mesh sieve held about an inch above a vessel of known volume and weight. The material was carefully leveled off and the vessel weighed. From the weight of the contained material and the volume of the vessel the cubic inches occupied by a pound of magnesium arsenate is readily calculated.

The pH value was determined by means of the LaMotte comparator, using the LaMotte color standards. Ten grams of the arsenate were mixed with 500 cc. of distilled water at room temperature (approximately 25° C.) and allowed to stand for two hours, with frequent shaking; then samples were filtered off, and the pH value determined. The pH of the distilled water used was 6.6.

The suspensibility test was made by shaking 1.2 gram samples of the arsenate in 500 cc. of distilled water at 25° C. This represented 2 pounds arsenate to 100 gallons of water. When thoroughly mixed the cylinder was allowed to stand at 25° C. for a definite time, and the top half (250 cc.) then siphoned off into a weighed beaker. The beaker was placed on the steam bath and its contents evaporated to dryness, then dried and weighed. The percentage of material held in suspension is found by multiplying the weight of the salts found on evaporation by 100 and dividing by 0.6. The data obtained by analysis are tabulated in Table 1.

The samples were submitted to microscopical examinations (5). Both samples were composed largely of small needles which had the following optical properties; the extinction is parallel and the sign of elongation is plus. The indices of refraction are $n\alpha = 1.578$ and $n\gamma = 1.60$, both $\pm .003$. These values are practically the same as those given by Barstow (3) for the basic compound $Mg_3(AsO_4)_2.MgO.YH_2O$. The chemical data reported here are insufficient to substantiate the presence

of this compound, although they do show a proportion of magnesium oxide more than sufficient to agree with it.

TABLE 1. ANALYSES OF COMMERCIAL MAGNESIUM ARSENATES

	Sample No. 1 Per cent	Sample No. 2 Per cent
Moisture	0.8	0.7
Total Arsenic Pentoxide (As_2O_5)	32.6	41.0
Water Soluble Arsenic Pentoxide (As_2O_5)	0.04	0.1
Water Soluble Salts at 25° C	2.5	2.6
Total Arsenious Oxide (As_2O_3)	0.1	0.2
Insoluble in Hydrochloric Acid Silicon Dioxide (SiO_2)	0.6	0.7
Aliminum Oxide, Al_2O_3; Ferric Oxide Fe_2O_3	0.3	0.8
Calcium Oxide (CaO)	1.4	1.5
Total Magnesium Oxide (MgO)	47.9	44.2
Cubic inches per pound	145	113
pH value of 2% suspension	9.8	9.8
Suspensibility:		
1.2 g./500 cc. H_2O at 25° C.		
2 min	78%	76%
5 "	33%	47%
10 "	16%	19%
30 "	9%	12%
60 "	8%	9%

APPLICATION AS INSECTICIDES. According to the earliest recorded account found, magnesium arsenate was first used as an insecticide in 1919, when it was sprayed on tree foliage, resulting in severe injury. Patten and O'Meara (6) found that magnesium arsenate was soluble in water containing carbon dioxide to the extent of 41.7 per cent of the total arsenic content.

Patten (7) in 1921 made a study of the solubility of calcium and magnesium arsenates in carbon dioxide and its relation to foliage injury.

Cook and McIndoo (8) tested several new arsenicals, namely, the arsenates of barium, copper and barium, magnesium, and aluminum. None showed as high toxicity as acid lead arsenate. They concluded that chemical analysis does not give sufficient data to judge satisfactorily its insecticidal properties.

Marcovitch (9) in 1924 recommended a spray of magnesium arsenate (2 pounds to 100 gallons of water) to be applied to the lower surface of the leaves of the bean plant in the control of the Mexican bean beetle.

Miller (10) describes the use of magnesium arsenate dust (1 pint magnesium arsenate to 5 pints hydrated lime) in the control of the Mexican bean beetle. The results in regard to yield of beans and control of beetles were equal to those obtained with lead or calcium arsenates. Slight injury was reported as resulting from the use of calcium, magnesium, and lead arsenate.

The Report (11) of the Entomologist of the United States Department of Agriculture for 1925 states that calcium and magnesium arsenate at

high dilution are more effective than sodium fluosilicate against the Mexican bean beetle.

Leach (12) experimented with the basic and acid arsenates of lead as soil insecticides. He found that certain arsenates are toxic to the larvae of the Japanese beetle (*Popillia japonica* Newman), but that the basic arsenate of lead, and the arsenates of magnesium and iron (scorodite) are non-toxic. The arsenates non-toxic to the larvae proved to be non-toxic to the plants.

Guyton and Knull (13) recommended the use of magnesium arsenate as dust or as a spray in the control of the Mexican bean beetle. The water soluble arsenic content should not be in excess of 0.5 per cent calculated as arsenic pentoxide (As_2O_5).

Melander and Spuler (14) used magnesium arsenate in a poison bait against the strawberry root weevil. They found that it was the most effective of the poisons tried and that it gave good control.

Eddy and McAllister (15) found that magnesium arsenate caused less injury to bean plants when diluted with four parts hydrated lime and that it was as toxic to the Mexican bean beetle as any material tried. The compounds tested were: The fluosilicates of calcium, barium and sodium; and the arsenates of calcium, magnesium, lead and zinc.

Smith (16) used magnesium arsenate in direct application for the control of black vine weevils.

Cecil (17) recommends the use of magnesium arsenate as dust or as a spray in the control of the Mexican bean beetle.

Urbahns (18) says that magnesium arsenate has been considered unsafe for spraying upon foliage, but that it is coming into more general use in connection with poison bait for the control of strawberry root weevils, and possibly other forms, such as the vegetable weevils.

Downes (19) experimented with a poisoned apple-waste bait against the strawberry root weevil. He used sodium fluosilicate, calcium arsenate and magnesium arsenate: All gave good results.

Mote and Wilcox (20) used a poisoned bean bait, which gave 100 per cent mortality in 12–23 hours in laboratory tests against *O. ovatus* and *O. rugifrons*.

Snapp (21) carried out a series of experiments with a number of insecticides on peach trees to determine their effectiveness against the plum curculio (*Conotrachelus neunphar*). Magnesium arsenate did not give as good results as lead arsenate.

Howard (22) says that calcium or magnesium arsenate with lime is superior to sodium fluosilicate for the control of the Mexican Bean beetle.

Alden and Yeomans (23) experimented with the new arsenical sprays against the codling moth in Georgia.

All gave poor results when compared to lead arsenate, and most of them injured the foliage severely. Magnesium arsenate gave the best results of the new sprays.

In the Report (24) of the Committee of Economic Entomologists to formulate plans for investigating the codling moth, a summary of four laboratory and twelve field tests shows that magnesium arsenate is about one-half as effective as lead arsenate in controlling the codling moth. Severe injury to the foliage in several cases was recorded.

Caffrey and Huber (25) say that the application of insecticides, including magnesium arsenate, invariably has proved ineffectual in protecting growing corn from injury by the European corn borer in all experiments conducted up to the present time.

References

1. Methods of Making Magnesium Arsenate. U. S. Patent No. 1,344,018, By Edwin O. Barstow. Filed Sept. 16, 1918. Patented June 22, 1920.
2. Insecticide and Method of Making Same. U. S. Patent No. 1,420,978. By Herbert H. Dow. Filed Jan. 27, 1919. Patented June 27, 1922.
3. Insecticide and Method of Making Same. By Edwin O. Barstow. U. S. Patent No. 1,466,983. Filed Sept. 1, 1920. Patented Sept. 4, 1923.
4. Improvements Relating to the Manufacture of Fungicidal, Insecticidal and Like Media. By Wilfred Carpmael. British Patent No. 251,330. Application Jan. 27, 1925. No. 2435/25; Accepted April 27, 1926.
5. The microscopical examination was carried out by Mr. George L. Keenan of the Food, Drug and Insecticide Administration, Washington, D. C.
6. The Probable Cause of Injury Reported from the Use of Calcium and Magnesium Arsenates. By. A. J. Patten and P. O'Meara, Michigan Agr. Expr. Sta. Quart. Bull., Vol. 2, No. 2, pp. 83–84 (1919).
7. The Solubility of Calcium and Magnesium Arsenates in CO_2 and its Relation to Foliage Injury. By A. J. Patten, J. Assoc. Official Agr. Chem. *4*, pp. 404–406 (1921); C. A. *14*. p. 446 (1921).
8. Chemical, Physical and Insecticidal Properties of Arsenicals. By F. C. Cook and N. E. McIndoo, U. S. Dept. Agr. Bull. 1147, pp. 1–55 (1923).
9. New Insecticides for the Mexican Bean Beetle and Other Insects. By S. Marcovitch, Tenn. Agr. Exp. Sta. Bull. 131 (1924), R. A. E. Ser. A. *13*, 118 (1925).
10. The Mexican Bean Beetle. By A. E. Miller, Ohio Agr. Exp. Sta. Monthly Bull. 9, No. 11–12, pp. 197–204 (Nov. Dec. 1924) R. A. E. Ser. A. *13*, 328 (1925).
11. Report (1923–1924) of Entomologist. U. S. Dept. Agr. pp. *35* (1925).
12. Experiments with Certain Arsenates as Soil Insecticides. By B. R. Leach, J. Agr. Res. *33*, 1–8 (1926) R. A. E. Ser. *14*, 526–527 (1926).
13. Mexican Bean Beetle in Pennsylvania. By T. L. Guyton and J. N. Knull, Penn. Dept. Agric. Gen. Bull. 417, (1925) R. A. E. Ser. A, *14*, 352 (1926).
14. Poisoned Baits for Strawberry Root Weevils. By A. L. Melander and A. Spuler, Wash. Agr. Exp. Sta. Bull. *199*, 22 (1929) R. A. E. Ser. A. *14*, 271 (1926).
15. The Mexican Bean Beetle. By C. O. Eddy and L. C. McAlister, Jr. So. Carolina Agr. Exp. Sta. Bull. 236, pp. 3–38 (1926) (Ann. Report 1926–1927).

16. The Black Vine Weevil as a Pest in Greenhouses and Nurseries. By F. F. Smith, J. Econ. Ent. *20*, 127–131 (1927).
17. The Mexican Bean Beetle. By Rodney Cecil, N. Y. Agr. Exp. Sta. Circular 96 (1927).
18. Commercial Insecticides and Some of their Uses. By T. D. Urbahns, California Dept. Agr. Monthly Bull. 16, No. 10, pp. 525–536 (Oct. 1927).
19. Recent Developments in Strawberry Root Weevil Control. By W. Downes, J. Econ. Ent. *20*, 695 (1927).
20. The Strawberry Root Weevils and Their Control in Oregon. By D. C. Mote and J. Wilcox, Ore. Agr. Exp. Sta. Circular No. 79 (Feb. 1927).
21. A Preliminary Report of Toxic Value of Fluosilicates and Arsenicals as Tested on the Plum Curculio. By O. I. Snapp, J. Econ. Ent. *21*, 175–178 (1928).
22. Some Notes on the Mexican Bean Beetle Problem. By N. F. Howard, J. Econ. Ent. *21*, 178–182 (1928) C. A. *22*, 2024 (1928).
23. Codling Moth Control in Georgia Apple Orchards. By C. H. Alden and M. S. Yeomans, J. Econ. Ent. *21*, 319–324 (1928).
24. Report of Committee of Economic Entomologists to Formulate Plans for Investigations of Codling Moth from Biologic and Control Standpoints, J. Econ. Ent. *21*, 36 (1928).
25. The Fundamental Phases of European Corn Borer Research. By D. J. Caffrey, and L. L. Huber, J. Econ. Ent. *21*, 104 (1928).

STUDIES IN APPLE MAGGOT CONTROL IN THE HUDSON VALLEY

By F. G. Mundinger, *Hudson Valley Fruit Investigations*

Abstract

The timing of poison applications for apple maggot, *Trypeta pomonella*, is best determined by the use of large emergence cages under nearly natural conditions. Arsenate of lead, 2½ pounds to 100 gallons, applied as the flies are beginning to increase in numbers and a second application about ten days after the first give a large measure of protection. It is well to observe early varieties and protect them first. The maintenance of a poison cover, spray or dust, during the pre-oviposition period seems to be a very promising safeguard.

In 1925 many orchardists thru-out the Hudson Valley sustained severe financial losses due to the apple maggot and in succeeding years a number of orchards not carefully guarded were badly infested by the pest. During the last four years a part of each season was devoted to the study of the maggot. Data regarding its habits have been secured and various materials were used experimentally in an attempt to develop control measures.

It has long been known that the apple maggot passes the winter in the soil as a puparium and that it makes its appearance during the summer months as the adult or apple maggot fly. Little information on the time and manner of appearance of the flies was available for this region so a

study of emergence was the first step taken in the work. In order to proceed under conditions as nearly natural as possible, large trap cages 10ft. by 4 ft. by 3 ft., made of light wooden strips and cheese cloth were placed thru-out the orchards under trees which had shown heavy infestation the previous year. Every cage covered forty square feet of soil and was made as fly-tight as possible. One end was so arranged that entrance was easily gained for observation and collection of flies.

About fifteen such cages were used each year on new locations. Several other cages were left on their original sites to determine the numbers of two-year flies emerging. A few cages were also established each year over early infested apples to study the possibilities of a double brood in one season. Observations of all cages were made daily.

Figure 67 shows in graphic form the emergences for the several years, 1926, 1927, 1928 and 1929. It will be noted that the period of maximum emergence varied somewhat in duration and in the time of occurrence

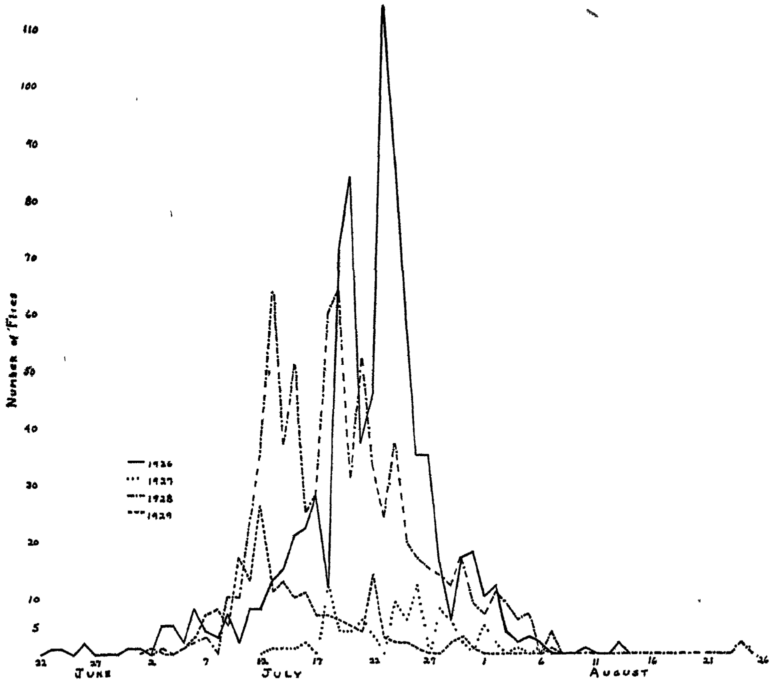

FIG. 67.—Emergence records of apple maggot flies.

during the four years, which shows that the calendar dates cannot be depended upon for timing protective applications. The yields of the cages varied considerably, some producing a few flies and others, as

many as forty-four per day. One cage, blown over during a rain storm and reset, yielded twenty-nine flies in one hour.

Temperature may play a role in emergence, for in the above instances the periods of maximum emergence followed the first series of warm days after July 1st. It seems reasonable to believe that soil moisture may be a factor of some importance in this respect since the greatly reduced emergences of 1927 and 1929 paralleled corresponding dry months. More flies were obtained from cages on uncultivated soil than from cages over areas where the soil had been disturbed. Early varieties showed a somewhat earlier maximum emergence period than late varieties. In 1927 only fifteen flies were taken from fifteen cages left on original sites for two seasons, indicating that the great majority of flies have a life cycle of one year in this area. The probability of two broods in one season also appears very slight.

Considering that there are indications of varietal differences affecting the maximum emergence periods and, that the progressive manner of emergence of the flies of each tree is so similar in character to that of the aggregate of all the trees, one may infer that there is probably a rather definite duration for pupation. Hence, seeded cages supplied with a mixture of apple varieties or containing fruits gathered at random with no regard as to the time of dropping, may or may not show an accurate picture of the emergence. There is some evidence that one may be misled in timing protective applications by data gathered from such traps. It is felt by the writer that emergence cages established under the most natural conditions are the surest indicators of the character of apple maggot emergence.

Since the flies have been found to feed for a considerable time before ovipositing, it is not advisable to begin protective measures at the sight of the first fly but to wait until the numbers of flies appearing in the large cages increases daily, indicating that the peak of emergence is near. Accordingly, various materials were used in spray and dust form to poison the flies during the preoviposition period. In some instances four applications were made and in others, only one. The table lists the details and results of these experiments. Control data was gathered on several different varieties but it was desired to make a comparative list of but one variety here. The efficiency of the materials in control was determined by a close inspection of all apples from each tree by means of a hand lens. Drops were quartered and otherwise dissected to learn the extent of their infestation. Dirty fruit was washed or wiped so that observation could be made more exact. Table 1 shows the results of the treatments.

Though not previously planned, the same Jonathan blocks were used during the three years of experimental work. It is interesting to note that the infestation by maggot in these blocks in 1925, was severe. Hence, extra precautionary measures were taken in 1926 and the results were very satisfactory. In 1927 emergence in this area was light, probably due to the excellent control the previous season and, dry weather. Applications were delayed in waiting for evidence of the approaching peak. Both spray and dust gave promising results. However, an untreated McIntosh orchard near-by was badly infested and the apples were gathered early because of the severe dropping. In 1928 the Jonathan blocks were given no experimental attention, treatments were delayed and as a result both Jonathans and Wealthies in this orchard were rendered unmerchantable by the pest. Also, an untreated McIntosh orchard under observation was found to be badly infested. In 1929 the Jonathans were again taken over for experimental work. Emergence appeared light so that the lead arsenate in the second spray was reduced from two and a half to two pounds per hundred gallons of spray. The trees were not drenched because of possible spray residue and as a result the control was not so complete as anticipated, but the crop as a whole was good. Wealthies in the same orchard and usually heavily infested came thru with very little maggot. Check trees left among treated trees undoubtedly received some protection from drifting spray.

The McIntosh orchard so badly attacked by maggot in 1927 was taken over for experimental work in 1928. Two sprays, the first applied just before the peak of emergence and a second about ten days later showed very promising results of control with lead arsenate as above used. An interesting phase of this work, was that of gathering the drops from each tree at three successive dates. On examination it was found that the apples of the second collection, seven days after the first gathering were more heavily infested than those of the first. The apples gathered last were mainly those knocked down by pickers. In all but one case they outnumbered the apples of the combined two previous collections but had very little maggot. Likewise Wealthies harvested in three successive lots showed a slight gain in maggot at each collection. This indicates that much damage can be done by the pest during the latter part of the growing season if a protective cover is not maintained.

Small screened observation cages set up thru-out the orchards provided opportunity for securing some data on the habits of the flies and their susceptibility to poisons. Most of the cages enclosed fruited spurs which had been treated with sprays and dusts, while others served as

checks. Three cages were maintained for each type of spray or dust. Into one cage of each lot sugar solution was sprayed daily, into another, clear water was introduced while the third was left unchanged. Usually five flies of known age were placed in each cage. As a rule flies in check cages without extra food or water lived but little longer than flies on poisoned foliage. In most instances flies on wetted, poisoned foliage died more quickly than where the foliage was not wetted. Flies on poisoned foliage, fed with sugar daily, lived as long as twenty-seven days and to a great extent paralleled the checks also sugar fed. Not too drastic conclusions can be drawn from the trials with these small cages since the sugar solutions dried on the wire screening and provided poison free areas for feeding.

In conclusion, it appears that the timing of poison applications for apple maggot is best determined by the use of large emergence cages under conditions as nearly natural as possible. One application of spray containing two and a half pounds of lead arsenate to one hundred gallons of the spray, as the flies are beginning to increase in numbers in the cages, and a second spray of the same lead arsenate content about ten days or so after the first, according to intervening weather conditions, will give a large measure of protection from apple maggot. Under dry conditions dust may be used in place of the second spray,or in dry seasons dust may be used altogether. It is well to carefully observe early varieties and protect them first. It has been demonstrated in this work that success in one season is not a guarantee of future freedom from maggot. Where the insect is known to occur in dangerous proportions two spray applications should be made even in the face of a seemingly light emergence. The maintenance of a poison cover whether spray or dust, during the preoviposition period of the flies seems to be a very promising safeguard against apple maggot.

RESULTS OF EXPERIMENTS ON THE CONTROL OF APPLE MAGGOT IN JONATHANS FOR THE YEARS 1926, 1927 AND 1929

Material	Dates of application	Picked apples		Drops		Tree totals		
1926		Total No.	Percent maggot	Total No.	Percent maggot	Total No.	Percent maggot	Percent drop
Spray: Lead arsenate (1) 2½–100, Kayso, water	7/8							
Dust: 80–10–10 (2)	7/17; 7/24	902	1.1	320	2.5	1222	1.4	26.2
" 50–40–10 (3)	8/4							
(1 tree)								
Dust: 80–10–10 (2)	7/7; 7/17							
" 50–40–10 (3)	7/25; 8/4	843.3	2.3	171.7	6.5	1015	2.7	22.3
(Average of 3 trees)								

1927								
Spray: Lime-sulfur 1–40 kayso, lead arsenate 2½–100. (Average of 3 trees)	8/2	1408.7	3.8	208.3	13.1	1617	5.2	14.5
Dust: 90–10 (4) (Average of 3 trees)	8/6	1326.3	2.4	217.7	13.3	1544	3.97	14.4
Check: (Average of 3 trees)		894.3	12.	213.6	32.3	1108	16.6	20.1
1929								
Spray: Dry-mix, (5) arsenate of lead 2½–100 (A) (7) Dry-mix, (A) lead arsenate 2–100. (Av. 2 trees)	7/13 7/24	1289.5	7.1	111	7.1	1400.5	7.1	7.9
Spray: Dry-mix, (A) lead arsenate 2½–100 (1 tree)	7/13	1499	10.3	84	15.5	1588	10.5	5.3
Spray: Sulfur, tobacco, Kayso,(A) lead arsenate (6) 2½–100 Sulfur, tobacco, kayso, lead arsenate 2–100 (Average of 2 trees)	7/13 7/24	1544	7.1	87.5	4.95	1582.5	7	5.6
Spray: Sulfur, tobacco, (A) lead arsenate 2½–100, kayso. (1 tree)	7/13	1914	9.9	126	19	2040	10.7	6.2
Spray: Dry-mix, (B) lead arsenate 2½–100 Dry-mix, (B) lead arsenate 2–100 (Av. 3 trees)	7/14 7/25	936	7.4	107.7	7.2	1043.7	7.1	8.6
Spray: Dry-mix, lead arsenate (B) 2½–100	7/14	2460	14.6	156	9.6	2616	14.2	5.96
Spray: Lime-sulfur, (A) lead arsenate 2½–100 Lime-sulfur, kayso, (A) lead arsenate 2–100 (Average of 2 trees)	7/16 7/25	2999	11.9	250	13.	3249	12.	7.7
Spray: Lime-sulfur, 1–40 kayso, (A) lead arsenate 2½–100 (Average of 2 trees)	7/16	2187.5	11.7	188	15.2	2375.5	11.9	7.25
Check (among sprayed trees)		2167	12.7	135	7.4	2362	12.4	5.9
Check (more isolated, in orchard sprayed late)		495	30.3					

NOTE: 1. 2½ lbs. lead arsenate to 100 gallons of spray.
2. 80 lbs. sulfur, 10 lbs. lime and 10 lbs. lead arsenate.
3. 50 lbs. sulfur, 40 lbs. lime (hydrated) and 10 lbs. lead arsenate.
4. 90 lbs. sulfur and 10 lbs. lead arsenate.
5. 16 lbs. sulfur, 8 lbs hydrated lime and 4 oz kayso in 100 gallons spray.
6. 16 lbs. sulfur, 8 lbs. tobacco dust and 4 oz kayso in 100 gallons spray.
7. (A) (B) two different commercial brands of lead arsenate.

Scientific Notes

Note on Plebeius acmon Doubleday and Hewitson. On April 4, 1930, Dr. H. Schmidt, Veterinarian, Texas Agricultural Experiment Station, found the pods of *Astragalus trifloris* Gray to be heavily infested with lepidopterous larvae, apparently of one species. The locality was about thirty-five miles south of Marfa, Texas. A number of the infested plants were brought back to College Station and turned over to the Division of Entomology. An attempt was made to rear the larvae to maturity on the plants but it was impossible to keep the plants from drying up. Since *Astragalus trifloris* does not occur in the vicinity of College Station, a number of larvae were transferred to the pods of English peas. The larvae did not take readily to this food supply but four of them finally pupated. From these pupae four butterflies emerged. These were identified by Dr. W. Schaus of the Bureau of Entomology, U. S. D. A. as *Plebeius acmon* Doubleday and Hewitson.

Astragalus trifloris, known by the common name of Garbancillo, is thought by the ranchmen of the vicinity of Marfa to be poisonous to livestock. About eighty per cent of the pods of the plants examined were infested.

ROBERT K. FLETCHER, *Division of Entomology, Texas Agricultural Experiment Station*

A New Method of Distributing *Empoasca fabae* (Harris). Early in 1930, Mr. Lacy McColloch of the Bureau of Plant Industry, U. S. Department of Agriculture, called attention to insects on green beans which had been shipped from Florida, and which were being used for study of certain diseases of beans in cold storage at Arlington Farm by Dr. J. I. Lauritzen. The insect proved to be the potato leafhopper, *Empoasca fabae* (Harris). Apparently there is no previously published record that this species deposits eggs in the pods of green beans under field conditions. These insects were received in green beans of the Bountiful variety as early as January 27 from Fort Lauderdale, Florida, and later they were abundant in the beans received from Delray Beach, Florida, as many as seven individuals hatching from a single bean pod. Investigation also revealed the presence of small leafhopper nymphs on green beans which had been received from Florida and were being offered for sale in Center Market, Washington, D. C.

Records on hatching were noted in two instances, as follows: Beans received March 14, which had been kept in individual lots at temperatures of 21°, 25°, 27°, and 29° C., respectively, showed little difference in the time and amount of hatching when kept at room temperatures in the laboratory following their removal from storage on March 21; a second series of four lots of material, kept at 4.5°, 7°, 12°, and 15° C., respectively, for a week preceding March 28, was kept under observation at room temperatures following this period. It was found that hatching continued until April 17 in the case of the lot which had been kept at 15° C. Less hatching apparently occurred in the lots which had been kept in storage at the lower temperatures.

Upon inquiry, I was advised by Mr. W. H. White of the Division of Truck-Crop Insects, Bureau of Entomology, that a similar instance, whereby *Empoasca* was shipped to Washington in beans from Florida, was called to his attention in 1927 by Dr. L. L. Harter of the Office of Vegetable and Ornamental Diseases, Bureau of Plant Industry.

F. W. POOS, *Bureau of Entomology, U. S. Department of Agriculture*

// JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

AUGUST, 1930

The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication at $2.50 per page for all matter in excess of six printed pages, a part page counting as a full page, this limit not including acceptable illustrations. Photo-engravings may be obtained by authors at cost.

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ANNUAL SCIENTIFIC MEETINGS: 1930-31, Cleveland; 1931-32, probably New Orleans; 1932-33, Chicago; 1933-34, undecided; 1934-35, probably Rochester.

Few can keep in touch with the exceedingly diverse literature of entomology. One of the more recent additions is entitled: Mediterranean Fruit Fly, Hearing Conducted at Orlando, Florida, by the Special Subcommittee of the House Committee on Appropriations. There are only 1483 printed pages. It is verbose. It reflects the opinions and beliefs of diverse individuals and the reader, whether in favor of eradication or opposed to it in one or more phases, can find within the volume endorsement of his views. One can not but commend the desire of the committee to get at the facts in the face of diverse and sometimes contradictory statements. It is evident that an astonishing reduction in the infestation was effected. There is, as was to be expected, diversity of opinion as to the wisdom or necessity of certain regulations and their enforcement. One may find strong condemnation of certain types of publicity. It is an illuminating publication in its presentation of the psychology of one phase of quarantine and as such may prove a real contribution to economic literature. The last ten years has witnessed a remarkable development in quarantine work and it is only by a careful study of all phases that a satisfactory policy can be determined. This volume on the Mediterranean Fruit Fly is available through the Government Printing Office and in the writer's judgment is worthy of careful study by all interested in quarantine problems.

Reviews

A Manual for the Study of Insects, Revised Edition by JOHN HENRY COMSTOCK, ANNA BOTSFORD COMSTOCK and GLENN W. HERRICK, Nineteenth Edition, pages i–xiii, 1–401, 635 test figures, 3 plates. Comstock Publishing Company, Ithaca, N. Y., 1930.

It was the reviewers good fortune to see a little of the work involved in the preparation of the first edition of this classic of American entomology and it has been a source of gratification to note subsequent editions. This series of "Manuals" have meant much to the entomological students of America and have had a determining influence upon the development of the science throughout the world, since they represent years of productive labor by a master and his associates in the general field of entomology, as well as occasional departures into a few specialized fields. The Comstock Manuals have abundantly justified themselves and carry their own credentials. All familiar with them will rejoice greatly in this latest edition, with an additional co-author, somewhat condensed, conserving most carefully the general lines of the earlier editions and brought down to date.

E. P. F.

Current Notes

Mr. R. E. Balch, Entomological Branch, is at present on Cape Breton Island conducting investigations on the black-headed budworm, *Peronea variana.*

Dr. J. M. Aldrich, of the U. S. National Museum staff, has gone to the western United States for two months and will spend some time there collecting Diptera in high altitudes.

Mr. James B. Gahan, who received his B. S. degree in June, from the University of Maryland, has been appointed to a position with the Bureau of Entomology. He will work at the Sligo, Maryland, Laboratory.

O. E. Gahm, Bureau of Entomology, Arlington, Va., and H. D. Young, of the Bureau of Chemistry and Soils, visited Barberton, Ohio, May 19 and 20, to conduct some experimental tests on fumigation in the mushroom plant of Yoder Brothers.

O. E. Gahm, Bureau of Entomology, Arlington, Va., left Washington, May 31, for points in the West and the Pacific Coast, to study the occurrence of mushroom pests in commercial mushroom houses. He returned to Washington, July 8th.

Field assistants, Bureau of Entomology, who have recently been appointed are W. C. Pierce, for service at Baton Rouge, La., E. B. Wiggins, at Estancia, N. M., L. L. Odom, at Bay St. Louis, Miss., A. L. Strand, at Walla Walla, Wash., and W. J. Gertsch, at Richfield, Utah.

In May four students, H. A. Bess, of the University of Florida, G. G. Cannon, of the University of Kansas, and D. W. Farquhar and C. W. Lacaillade, Jr., of Harvard University, were given temporary appointments as field assistants at the Gipsy-Moth Laboratory, Melrose Highlands, Mass.

Mr. Ralph Hopping, Entomological Branch, left Vernon, B. C., on April 6, for California, where he is spending two months sick leave. During his absence Mr. W. G. Mathers, who has returned from taking graduate studies at Syracuse University, will take charge of the Vernon forest insect laboratory.

Dr. A. G. Böving, the Bureau of Entomology specialist on coleopterous larvae, recently received from J. C. M. Gardner, of the Forest Research Institute and College, Dehra Dun, India, a series of beetle larvae, including cotypes of species described by him in an extensive paper on the immature stages of Indian Coleoptera.

W. E. Haley, Bureau of Entomology, of the field laboratory at New Orleans, La., spent about three weeks in May visiting the sugar-cane sections of Florida, to investigate the situation as to the sugar-cane moth borer, and to make a special study of the parasites of this insect.

Mr. K. E. Schedl, Entomological Branch, left Ottawa on May 3 for Biscotasing, Ont., where he is establishing a camp to study the biology of the jackpine sawfly, which is affecting jackpine over a large area. Mr. M. B. Dunn will shortly leave Ottawa for Kippewa, in western Quebec, to carry on similar studies.

General parasite breeding work is being continued at the Belleville, Ont., laboratory, Entomological Branch. On April 2, 18,000 wheat stem sawfly larvae infested with the parasite, *Collyria calcitrator*, were received from the Imperial Bureau of Entomology Parasite Laboratory at Farnham Royal, England. It is intended to liberate these parasites in areas infested with *Cephus cinctus*.

David Isler, Bureau of Entomology, who has been in charge of investigations on cultural control of the pink bollworm, has been transferred to Tallulah and placed in general charge of the mechanical investigations of the Division of Cotton Insects. This work is conducted in cooperation with the Division of Agricultural Engineering of the Bureau of Public Roads.

On May 31 R. A. St. George, Bureau of Entomology, left Falls Church for Ashville, N. C., to assume charge of the work at the field laboratory there for the coming summer. He will be assisted by R. W. Caird, of the University of Chicago, who is making a physiological study of trees attacked by the barkbeetle, and Messrs. Pawek and Huckenpahler, from the University of Minnesota.

Mr. Norwood A. Eaton, a graduate of the University of Maryland, B. S. 1927, M. S. 1928, has been appointed to a position with the state of Virginia. Mr. Eaton will have charge of the entomological laboratory which has been recently established at Charlottesville, Va. Mr. Eaton was with the Plant Quarantine and Control Administration after leaving college, first at the port of New York, and later Philadelphia.

The Division of Forest Insects, Bureau of Entomology, in cooperation with the Extension Service, has recently prepared a film strip on the control of subterranean termites attacking the woodwork of buildings. We believe that this strip will prove very useful to State entomologists and other entomologists who are called upon to remedy conditions where termites have attacked buildings. The strip will be ready in the near future.

W. A. Thomas, Bureau of Entomology, Chadbourn, N. C., visited Washington May 14, to make a survey of the strawberry plantings at Bell, Md., in company with G. M. Darrow, of the Bureau of Plant Industry. They went there to determine the varying susceptibility of the different varieties of strawberries to attack by insects. Mr. Thomas also made a survey for infestations by the strawberry weevil on the Eastern Shore of Maryland and in Delaware.

Professor and Mrs. Geo. A. Dean sailed from Montreal, Canada, July 12, on the S. S. "Duchess of York" for a business and pleasure trip to Europe. Professor Dean's official work in connection with insects infesting export flour will take him into England, Scotland, Ireland, Norway, Sweden, Denmark, Germany, Belgium, and Holland. Professor and Mrs. Dean hope they will also have time to visit France, Switzerland and Italy.

On April 11, Mr. A. B. Baird, Entomological Branch, returned from a brief visit to the corn borer laboratory at Arlington, Mass., with a large supply of cocoons of the corn borer parasites, *Microgaster tibialis* and *Eulimneria crassifemur*, emerging adults from which will be liberated later in the season. On April 28, a small shipment of *Chelonus inanitis*, a species which parasitizes the eggs of the European corn borer, was received from the Arlington Laboratory.

C. F. Moznette, Bureau of Entomology, in charge of pecan-insect investigations, with headquarters at Albany, Ga., and T. L. Bissell, of the pecan-insect laboratory at Experiment, Ga., attended the twenty-fourth annual convention of the Georgia-Florida Pecan Growers Association, April 18 and 19. Mr. Moznette presented a paper entitled "Relative efficiency of lead arsenate and calcium arsenate in controlling the pecan leaf case-bearer," and Mr. Bissell gave one entitled "Some facts about the pecan weevil."

Mr. Castillo Graham, who received his Bachelor of Science degree from the Mississippi Agricultural and Mechanical College in 1928, received his Master's degree in June from the University of Maryland. Mr. Graham has been connected with the Extension Service, University of Maryland, having charge of the spray service, and certain fruit insect investigations for the western portion of Maryland. Mr. Graham is located at Hancock, Maryland, during the summer months. He will continue work this fall toward his Doctor's degree.

R. A. St. George, Bureau of Entomology, spent the week of April 28 at Madison, Wis., attending the Forest-Service conference there, and took part in the proposed economic survey of forest resources. Doctors E. Bateman, Senior Chemist, and Caroline T. Rumbold, Assistant Pathologist, Forest Products Laboratory, were consulted regarding certain phases of the work in tree injections that is being conducted by the field laboratory at Ashville, N. C., with the object of finding a more economical method of control for trees attacked by the barkbeetle.

In May, Mr. B. R. Coad, Bureau of Entomology, visited the field laboratory at El Paso, Tex., for the study of the pink bollworm, the one at Tucson, Ariz., for investigating the thurberia weevil, and the one at Calexico, Calif., where investigations of the cotton leaf perforator are being conducted. He also inspected the activities of the Plant Quarantine and Control Administration in eradicating the pink bollworm in the Salt River Valley of Arizona. The various projects for the coming season were reviewed and future activities were outlined.

Dr. Clarence E. Mickel, Assistant Professor of Entomology and curator of the insect collection in the University of Minnesota, has been awarded a Guggenheim Fellowship for a year's study in Europe, to work on the neotropical and Philippine Mutillidae. Dr. Mickel will study principally in England, France and Germany where most of the type material for these faunas is to be found. The work will be a continuation of that carried on at the U. S. National Museum for the Bureau of Entomology during the summers of 1928 and 1929.

Leaving Washington May 8, W. H. White, Bureau of Entomology, visited the lower section of South Carolina, to look over locations there suitable for the establishment of a field laboratory devoted to work on the sandy-land wireworm. He visited the field laboratory at Chadbourn, N. C., and conferred with W. A. Thomas and C. F. Stahl on the problems of the strawberry weevil and the root aphid. He also stopped at Charleston, S. C., to discuss with W. J. Reid Jr., the problem of the seed-corn maggot, and returned to Washington May 12.

Dr. Filippo Silvestri, who has been visiting Professor at the University of Minnesota, giving a course of lectures on economic entomology during the spring quarter, has presented the library of the Department of Entomology at that institution with a complete set of his publications. It is therefore possible at the present time for students in America to secure very easily any paper of Dr. Silvestri's through the University Library Exchange offices. After leaving the University of Minnesota, Dr. Silvestri was guest for a week at the State College of Iowa at Ames and has since been collecting and visiting laboratories and institutions in the western states.

Mr. Harry Wells, of Chevy Chase, Maryland, and a graduate of the College of Engineering, University of Maryland, returned in March from a year's expedition in Central Borneo, where he was in charge of radio investigations for the All-American Mohawk Malaysian expedition. While in Borneo and later in Java, Mr. Wells sent the Department of Entomology two lots of exotic Lepidoptera. It is hoped that some of this material may prove interesting, as Wells and his companions penetrated deep into the jungles of Borneo, and no doubt made some of his collections in situations where entomologists have never been.

Mr. William T. Henerey, who received his Master of Science degree from the University of Maryland in June, was recently appointed Assistant Extension Entomologist for the Pennsylvania State College. Mr. Henerey will have charge of the western counties in the state. He succeeds Mr. Pepper, who has recently resigned. He is a graduate of Clemson College in the class of 1926. After leaving school Mr. Henerey spent a year with the International Health Board, working under, Dr. Mark F. Boyd at the Edenton, North Carolina, Laboratory, and the following year returned to the South Carolina Experiment Station to work with Dr. C. O. Eddy.

Doctor F. C. Craighead, Bureau of Entomology, spent May 14, 15 and 16 with Messrs. E. E. Carter, M. W. Thompson and A. L. Nelson, of the Forest Service, and L. G. Baumhofer, formerly with the Bureau of Entomology, on the Nebraska National Forest, in a field examination of the plantations at Halsey. The improved appearance of the yellow pine trees resulting from the decrease in infestation of the tip moth brought about by the introduction of the parasite Campoplex was most gratifying. It is hoped that the parasite will bring about sufficient control to permit of the growth of this important species of yellow pine in the vicinity of Halsey. Plans for carrying out control work against infestation by the pitch moth in jack pine were considered and will probably be put into effect next fall.

Professor William B. Herms, Professor of Parasitology at the University of California, gave an illustrated lecture at the Franz Theodore Stone Laboratory of the Ohio State University, at Gibraltar Island, Put-in-Bay, Ohio, on the evening of July 25th. His lecture dealt mainly with the fauna and flora of certain typical coral atolls of the Mid Pacific Ocean. Professor Herms is a visiting

professor at the Ohio State University during the summer quarter, where he is giving a graduate course in Medical Entomology and is directing the work of certain graduate students in this field. He will return to his post in Berkeley, California early in September.

The 421st regular meeting of the Washington Entomological Society was held at the University of Maryland, College Park, on the evening of June 5th when the members of the Department of Entomology of the University were hosts to the Society. Prior to the meeting in the University Auditorium, more than a hundred members of the Society and their families spread box lunches on the campus and enjoyed a picnic supper. The Department of Entomology supplemented the box lunches with ice cream and milk drinks from the University Dairy. The party then proceeded to the University Auditorium where Dr. H. J. Patterson, Dean of the College of Agriculture and Director of the Experiment Station, welcomed the Society to the Maryland campus. Following a presentation of a chronological list of entomologists who had worked at Maryland by Dr. Ernest N. Cory, Head of the Entomology Department, Dr. L. O. Howard gave a most interesting discussion of some of the early entomologists at Maryland, with particular reference to C. V. Riley and Townend Glover. Dr. W. Dwight Pierce gave a review of some of the work he has been doing in the Phillipine Islands on the effect of temperature and moisture on insect life. Before adjournment the Society gave a rising vote of thanks to Dr. Cory and his assistants for a most enjoyable evening.

Horticultural Inspection Notes

The Oregon State Agricultural College in June issued Circular of Information No. 30, entitled "Recommendations for Eradication of Nematodes from Narcissus."

Mr. L. R. Warner, in charge of port inspection work for the State Plant Board of Florida at Key West, is reported to be ill at his former home in Pennsylvania.

Under Amendment No. 1 to Arizona Quarantine No. 1, on account of the alfalfa weevil, the importation of Idaho apples in baskets as well as boxes has been authorized.

Colonel Aird, a lily grower, has recently been made a member of the State Board of Horticulture of Oregon, and to him the Board has delegated general responsibility for narcissus inspection in that State.

Mr. R. N. Dopson, Jr., is at present employed in making inspections of the premises and environs of peach-growing nurseries in Georgia and Alabama, under the provisions of the Federal phony peach disease quarantine.

Mr. E. J. McNerney, who has been assisting in the enforcement of the car cleaning requirements of the Mediterranean fruit fly quarantine at New York and various other points during the past year, has been transferred to Boston, where he will be engaged in similar work.

A special meeting of the Southern Plant Board was held at Gatlinburg, Tennessee in the new Smoky Mountain National Park, on July 16. In addition to delegates from the southern States, there was present Mr. Lee A. Strong, Chief of the Federal Plant Quarantine and Control Administration.

Mr. J. M. Corliss of the Chicago office of the Plant Quarantine and Control Administration spent several days in Michigan during June, visiting the premises of

narcissus growers and conferring with the State inspectors who were engaged in the field inspection of narcissus at that time.

The Connecticut Agricultural Experiment Station in May published Circular 70, entitled "Nursery Sanitation Zones," by J. E. Riley, Jr. The circular includes maps of the various blister rust control areas established in Connecticut around the principal pine-producing nurseries of that State.

Mr. Hunter H. Kimball, who has been Chief Inspector of the Mississippi State Plant Board for several years, resigned in May to accept an appointment with the U. S. Department of Agriculture in charge of field scouting and eradication activities connected with the Mediterranean fruit fly campaign in Florida.

The production and harvesting period of Florida grapes and host vegetables has been extended by the United States Department of Agriculture to July 16 for cantaloupes and host vegetables, and August 1 for grapes. The new order became effective June 21, and was published as circular PQCA-282.

Mr. G. C. Chauncey, who has been stationed at the railroad diversion point at Waycross, Ga., to aid in the enforcement of the Mediterranean fruit fly quarantine regulations, and Mr. L. L. O'Steen, who has been similarly engaged in Savannah, Ga., have been transferred for the summer to the fruit fly work in Florida, with headquarters at Orlando.

Mr. G. W. R. Davidson of the Plant Quarantine and Control Administration and Dr. L. M. Hutchins of the Bureau of Plant Industry, made an extended field trip through Alabama, Mississippi, Louisiana, Arkansas and Tennessee during May and June to search for possible phony peach disease infections. A few trees showing the symptoms of this disease were found at a number of locations on the trip.

Mr. R. A. Sheals and Mr. C. B. Beamer of the Plant Quarantine and Control Administration spent several weeks during June and July in the New England States and New York making special inspections of the environs of nurseries who have applied for special permits to ship white pines to lightly infected States under the provisions of Regulation 2 (d) of the Federal white pine blister rust quarantine.

On March 31, the Arkansas State Plant Board revised the restrictions governing the introduction of sweet potatoes and sweet potato plants to authorize their entry into that State under Arkansas permit, from the entire State of Oklahoma and from weevil-free areas Nos. 2 and 3 of Texas. Heretofore entry of these products from the entire State of Texas and from two counties in Oklahoma was prohibited.

The regulations supplemental to Federal quarantine No. 13, restricting the transportation of fruits and vegetables for Hawaii to the continental United States on account of the Mediterranean Fruit Fly and the melon fly, have been revised effective June 1 to add lily and ginger roots to the products which may be shipped to the mainland subject to inspection and certification in Hawaii. Other minor changes are made in the requirements.

Mr. C. R. Stillinger, in charge of the transit inspection work of the United States Department of Agriculture in the Pacific Northwest, with headquarters in Spokane, Washington, spent much of May and June assisting the Oregon State inspectors in making field examinations of narcissus plantings. The bulb eelworm has been found much more extensively scattered in Washington and Oregon than had previously been believed.

On April 8, the Plant Quarantine and Control Administration issued regulations governing the compensation of farmers on account of losses which may be sustained because of the enforced nonproduction of cotton in noncotton zones established for the purpose of eradicating the pink boll-worm. These regulations are primarily applicable at the present time to the pink bollworm outbreak in the Salt River Valley of Arizona.

On June 19 the Maryland Agricultural College and the State Board of Agriculture issued a revision of the State quarantine regulating the intrastate movement of nursery stock, farm products and soil to prevent the spread of the Japanese beetle. In addition to including all the requirements of the Federal quarantine on this subject, the State regulations provide special additional restrictions on the intrastate movement of these products into certain sections of Baltimore and Harford counties.

The Federal white pine blister rust quarantine regulations were revised on June 5. The primary purpose of the revision was to extend the area designated as infected with the blister rust to include the State of Montana and those parts of Oregon not heretofore so designated. Other changes of general interest related to the movement of Christmas trees, the removal of certain special sanitation requirements so far as they applied to the shipment of five-leafed pines from New York to the New England States and vice versa, and the placing of additional restrictions on the movement of five-leafed pines from Oregon and Idaho.

Mr. Paul H. Millar, Chief Inspector of the Arkansas State Plant Board, reports that during the fiscal year ended June 30, 1930, inspectors of the Board made terminal and transit inspections of 4,072 plants in 53 shipments of nursery stock and condemned 40 such plants. The pests and diseases involved were largely woolly aphis, crown gall and blotch canker. This was in addition to the inspection of 1,486 crates of onions from Texas, of which 114 were condemned on account of pink root disease, and 598 crates of strawberry plants from Arkansas, Iowa, Indiana, Kansas, and Maryland, of which nine crates were condemned as containing old plants and thirty-three crates on account of nematode infestation.

Cotton produced in the counties of Chaves, Eddy and Otero in New Mexico; the counties of Andrews, Glasscock and Martin, and the regulated parts of Borden, Dawson and Howard in Texas, was released by the Plant Quarantine and Control Administration from the fumigation requirement, effective June 1. In making the announcement the Administration stated that these were counties within which and within five miles of which no pink billworm infestation had been found during the past two crop seasons, also that no infested seed cotton is known to have been ginned in that area during this period, and that all cotton seed produced therein is being satisfactorily sterilized in cotton seed heating machines. The release from the fumigation requirement does not apply to picker waste and forms of unmanufactured cotton fiber other than samples for commercial baled lint and linters.

The Atlanta office of the Administration which had acted as headquarters for the Mediterranean fruit fly work outside Florida has been discontinued. The road station activities on the Florida border will hereafter be directed from Orlando by Mr. L. M. Gaddis under the general direction of Prof. W. C. O'Kane, while the quarantine enforcement work at railroad diversion points in the South and the enforcement of the restrictions prohibiting reshipments of Florida products from northern to southern States will be administered by the Domestic Plant Quarantine

Office of the Administration at Washington, through Mr. G. W. R. Davidson, who will be in immediate charge. No general program of surveys for the fruit fly outside of Florida will be undertaken by the Federal department this season. Mr. P. A. Hoidale, who has been in charge of the Atlanta office for the past year, is resuming his former duties in charge of the Mexican fruit worm work at Harlingen, Texas.

Apicultural Notes

Harley W. Roath, L. E. McDonald, Russell Smith, and Wm. C. Northrup have been appointed Field Assistants, Bureau of Entomology, to help with experiments under way at the Intermountain Bee Culture Field Laboratory, Laramie, Wyo.

Dr. W. E. Dunham, of Ohio State University, has been given a temporary appointment to assist in experiments in the pollination of red clover, to be conducted this summer at Holgate, Ohio, by the Bee Culture Laboratory, Bureau of Entomology.

J. E. Eckert, of the Intermountain Bee Culture Field Laboratory, Bureau of Entomology, Laramie, Wyo., has been granted leave of absence to attend the graduate school of Ohio State University during the coming fall term, and has been appointed Fellow in Entomology for 1930–31.

Dr. L. M. Bertholf has been appointed Field Assistant, to continue investigations at the Bee Culture Laboratory, Washington, on the effect of various wave lengths upon the honeybee. At the termination of the temporary appointment Doctor Bertholf will go Munich, Germany, to study with Prof. Karl von Frisch, of the University of Munich, on a National Research Council fellowship.

Dr. Tomi Yoneda, of the Department of Animal Industry, Ministry of Agriculture and Forestry, Tokyo, Japan, visited the Bee Culture Laboratory at Washington, D. C., May 20 to consult with members of the staff on matters relative to the production, marketing and grading of honey. According to Doctor Yoneda, an effort will be made in Japan to interest farmers in keeping colonies of bees.

Dr. L. R. Watson, of Alfred, N. Y., formerly connected with the Division of Bee Culture Investigations, visited the Bee Culture Laboratory, Washington, D. C., in the latter part of May. Besides his investigations on the artificial insemination of queenbees and research on the composition of beeswax, Doctor Watson, with the assistance of Mrs. Watson, has developed a formula by which honey is utilized in the making of an unusually fine grade of assorted chocolate candy.

Notes on Medical Entomology

On May 17 F. C. Bishopp, Bureau of Entomology, visited Dr. Baer, of Johns Hopkins University, at Baltimore, Md., for consultation with regard to the use of blowfly maggots in treatment of cases of osteomyelitis.

Professor J. H. Ashworth of the Department of Zoology, Edinburgh University, recently spent a day visiting the Department of Entomology at Cornell University. He was particularly interested in the work being done in the field of Culicid biology.

Messrs. Arthur Gibson and C. R. Twinn, of the Entomological Branch, visited Montebello, Que., on April 12, to assist officials of the Lucerne-in-Quebec Community Association in planning work with a view of eliminating mosquitoes from the neighbourhood of this recently organized and important summer resort. Mr. Norman Atkinson, formerly an officer of the Branch, attached to the Saskatoon Laboratory, has been appointed by the Association to take charge of this project.

Mr. C. R. Twinn, of the Entomological Branch, visited Camp Borden, May 1–8, at the request of the Department of National Defence, to organize mosquito control work at the Air Force camp for the current season. While at Camp Borden, Mr. Twinn made aerial and ground surveys of the surrounding district and secured larval collections representative of the local mosquito fauna. Before returning to Ottawa a brief visit was made to Orillia where the local mosquito control committee is continuing its activities.

Mr. E. H. Hinman, a graduate student in the Department of Entomology of the New York State College of Agriculture at Cornell University has recently been appointed to a National Research Fellowship in the Biological Sciences. Mr. Hinman is a graduate of Queen's University, Canada, class of 1927. He received his doctor's degree at the June Commencement of Cornell University. While a graduate student, Mr. Hinman specialised in the field of Medical Entomology and has made a distinct contribution to the problem of the nutrition of aquatic organisms, particularly mosquito larvae. In association with Professor Robert Matheson he also contributed to an intensive study of the effects of aquatic plants on mosquito development and the value of plancton and bacteria as food factors in larval development. This latter work was made possible by a grant from the Heckscher Research Foundation of Cornell University. As a National Research Fellow Mr. Hinman will continue his investigations at Tulane University Medical College working in association with Dr. C. C. Bass, Dean of the Medical College, and Dr. E. C. Faust, Professor of Parasitology, in the same institution.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

VOL. 23 OCTOBER, 1930 No. 5

Proceedings of the Fifteenth Annual Meeting of the Pacific Slope Branch, American Association of Economic Entomologists

The 15th annual meeting of the Pacific Slope Branch was held at the University of Oregon—Eugene, Oregon—June 19 and 20, 1930. On Thursday the entomologists joined with the biologists for the annual dinner. On Friday afternoon there was an excursion to the Oregon State College and Experiment Station at Corvallis. The total attendance was 41, with the following members present:

L. P. Rockwood, Forest Grove, Ore.
W. V. King, Mound, La.
B. G. Thompson, Corvallis, Ore.
E. J. Newcomer, Yakima, Wash.
E. R. De Ong, San Francisco, Cal.
H. E. Burke, Palo Alto, Cal.
Trevor Kincaid, Seattle, Wash.
LeRoy Childs, Hood River, Ore.
A. J. Flebut, Berkeley, Cal.
Geo. M. List, Ft. Collins, Col.
Eugene S. Kellogg, Santa Barbara, Cal.
Anthony Spuler, Wenatchee, Wash.
Max M. Reeher, Forest Gr., Ore.
Joseph Wilcox, Corvallis, Ore.
T. R. Chamberlin, Forest Gr., Ore.
R. L. Webster, Pullman, Wash.
H. A. Scullen, Corvallis, Ore.
W. J. Chamberlin, Corvallis, Ore.
F. P. Keen, Portland, Ore.
Don C. Mote, Corvallis, Ore.
J. C. Elmore, Box 66, Garden Grove, Cal.

PART I.—BUSINESS PROCEEDINGS

The meeting was called to order by Chairman Don C. Mote, at 1:30 P. M. Thursday. J. C. Elmore served as acting secretary. The following committees were appointed: NOMINATING—Jos. Wilcox, R. L. Webster, F. P. Keen; RESOLUTIONS—E. J. Newcomer, G. M. List; AFFILIATION—L. P. Rockwood, H. E. Burke; AUDITING—W. J. Chamberlin.

Report of the Treasurer for 1930

Balance on hand June 20, 1929		$11.25
Interest		.52
Refund from Main Association		18.65
Paid out:		
Envelopes, registry and postage	$13.02	
Notices and title blanks	7.50	
Miscellaneous	2.50	
	$23.02	
Balance on hand June 20, 1930	$ 7.40	
	$30.42	$30.42

Chairman Mote read a proposal from E. O. Essig, for some years a member of the Affiliations Committee, proposing that a trial be given a winter meeting. After some discussion it was moved and carried unanimously that the Pacific Slope Branch hold but one meeting a year, to be held at the time and place of the meetings of the Pacific Division A.A.A.S.

Final Business Session

Chairman Mote called for the reports of Committees: The Nominating Committee presented the following names: Chairman, Roy E. Campbell; Vice-Chairman, H. E. Burke; Secretary-Treasurer, H. H. Scullen. The Resolutions Committee presented resolutions expressing appreciation to the University of Oregon for its hospitality; to Chairman Mote and Acting Secretary J. C. Elmore, for their efforts in arranging the meeting and program; and that if possible arrangements be made to send all members the printed program, whether members of the A.A.A.S. or not. The Auditing Committee reported the accounts of the Treasurer as correct. The Membership Committee presented 2 names for associate membership.

The reports of all the committees were accepted. On a vote of preference for time of meeting, the following was indicated: Summer—11, Winter—9, No preference—8. A motion was made and carried that hereafter we adhere to our custom of an entomologists dinner rather than combining with any other group.

It was announced that the 1931 meeting would be held in Pasadena, California.

PART II.—PAPERS AND DISCUSSIONS

Chairman Mote called the meeting to order at 2:30 P. M., and the following papers were presented:

FOOD CONSUMED BY THE CHINA PHEASANT IN OREGON

By Don C. Mote, T. A. Allen and Mrs. C. E. Chuster, *Oregon State Agr. College, Corvallis, Oregon.*

(Paper not received)

WHICH INSECTS ARE THE IMPORTANT ENEMIES OF SHADE, PARK, AND ORNAMENTAL TREES IN THE PACIFIC STATES?

By H. E. Burke, *Senior Entomologist, Division of Forest Insects, Bureau of Entomology*

Abstract

A list of 50 of the most important insect enemies of trees used for ornament, shade and park purposes in the Pacific States, ranked in importance according to information furnished by questionnaires sent to university, city, county, state and government men interested in insects.

Before we can conduct an intelligent campaign against the insect enemies of our trees in the Pacific States we must know the species we have to fight. In order to get this information in the quickest and easiest way possible and still with a reasonable degree of reliability, the writer, during April, 1929, sent out 105 questionnaires. These went to state entomologists, professors of entomology, directors of federal insect laboratories, superintendents of state highways, county horticultural commissioners, and superintendents of city parks in the states from Montana south to New Mexico and west to the Pacific. The questionnaire requested the correspondent to express his opinion on the relative importance of the insects injurious to trees in the area under his observation, and to note for each insect its distribution and principal host plants. Fifty-nine questionnaires were returned with the information desired.

The information furnished by the questionnaires returned, with that obtained by the writer and his associates during the past ten years, gives a very good general idea of the relative importance of the various species. It reveals what we know about their past importance, where they are important, and upon what species of trees they are important.

Ranking the insects, according to information obtained from the questionnaires, by giving the species marked first in importance a weight of ten for each time marked first and so on down to a weight of one each time marked tenth, we get a list showing the following species, weights, and relative ranks:

Rank	Weight	Species	
1	225	Red spiders	Probably several species
2	147	Pacific flathead borer	*Chrysobothris mali* Horn
3	146	European elm scale	*Gossyparia spuria* (Modeer)
4	126	Oyster-shell scale	*Lepidosaphes ulmi* (L.)
5	106	Mealybugs	*Pseudococcus* spp.
6	93	Black scale	*Saissetia oleae* (Bernard)
7	79	Elm leaf beetle	*Galerucella xanthomelaena* (Schrank)
8	78	Cypress bark beetle	*Phloeosinus cristatus* (Lec.)
9	77	Pacific oak twig girdler	*Agrilus angelicus* Horn
10	68	California oak worm	*Phryganidia californica* Pack.
11	65	Brown apricot scale	*Lecanium corni* Bouché
12	62	Green apple aphis	*Aphis pomi* DeGeer
13	50	Forest tent caterpillar	*Malacosoma disstria* Hbn.
14	47	Fall webworm	*Hyphantria cunea* (Drury)
15	33	Spruce gall aphis	*Adelges cooleyi* (Gill.)
16	29	Carpenter worm	*Prionoxystus robiniae* (Peck)
17	28	Pine leaf scale	*Chionaspis pinifoliae* (Fitch)
18	27	Pacific sycamore lace bug	*Corythucha confraterna* Gibson
19	26	Elm gall aphis	*Eriosoma americanum* (Riley)
20	21	Common flathead borer	*Chrysobothris femorata* Oliv.
21	20	Cottony maple scale	*Pulvinaria vitis* (L.)
22	20	Italian pear scale	*Diaspis piricola* (Del G.)
23	19	Western pine beetle	*Dendroctonus brevicomis* Lec.
24	19	Woolly elm-apple aphis	*Eriosoma lanigerum* (Hausmann)
25	16	Black Hills beetle	*Dendroctonus ponderosae* Hopk.
26	15	California tussock moth	*Hemerocampa vetusta* (Bvd.)
27	14	Willow leaf beetle	*Lina interrupta* (Fabr.)
28	13	Alder leaf beetle	*Haltica bimarginata* Say
29	12	Cottonwood leaf beetle	*Lina scripta* (Fabr.)
30	10	Hazel scale	*Lecanium coryli* (L.)
31	9	Turpentine beetle	*Dendroctonus valens* Lec.
32	9	Red scale	*Chrysomphalus aurantii* (Mask.)
33	9	Locust borer	*Cyllene robiniae* Forster
34	9	San Jose scale	*Aspidiotus perniciosus* Comstock
35	8	Grasshoppers	*Melanoplus* spp.
36	8	Satin moth	*Stilpnotia salicis* (L.)
37	8	Cottonwood leaf miner	*Proleucoptera albella* (Chambers)
38	8	Cottony cushion scale	*Icerya purchasi* Maskell
39	8	Douglas fir tussock moth	*Hemerocampa pseudotsugata* McD.
40	8	Box elder leaf roller	*Cacoecia semiferana* (Walker)
41	7	Willow scale	*Chionaspis salicis-nigrae* Walsh.
42	7	Greedy scale	*Aspidiotus camelliae* Sign.
43	7	Monterey pine engraver	*Ips* spp.
44	7	Black aphis	*Aphis rumicis* L.
45	6	Red-humped caterpillar	*Schizura concinna* (A. & S.)
46	5	Hemispherical scale	*Saissetia hemisphaerica* (Targ.)
47	3	Giant hardwood root borer	*Prionus californicus* Mots.
48	3	Oak gall defoliator	*Andricus bicornis* (McC. & Egb.)
49	3	Spiny elm caterpillar	*Aglais antiopa* (L.)
50	1	Hornet moth	*Alcathoe apiformis* (Clerck)

Half of the species appear to be introduced and half are natives. Of the first ten, the third, fourth, fifth, sixth, and seventh are introduced and the second, eighth, ninth and tenth are native.

Taking the area as a whole and the period of time as the past twenty years, the list undoubtedly gives a good general idea of the relative importance of the insect pests of our Pacific coast shade trees. For any one area or any one time, however, it does not hold. For instance, this season at Palo Alto we have received more inquiries about two small moth caterpillars which defoliate cypress than about any of the species on this list. One of these, *Argyresthia franciscella* Busck, is known, and the other, a leaf tier, appears to be unknown. Aphids may be very important in a moist climate like that of western Oregon and western Washington, and of no importance in a hot dry climate like that of southern California. On the other hand, red spiders may be important where the climate is dry and not so important where it is moist, or important during a dry season and unimportant during a wet one.

Much depends also upon the varieties of trees grown in the area under consideration. Certain scale insects which live only on subtropical plants may be very important in southern California and of absolutely no consequence in Montana, where neither they nor their host plants occur. The cottonwood leaf miner is important in Wyoming and Utah, where the cottonwood is an important tree, and unimportant in other areas where the cottonwood is little used.

About the only conclusion that it is safe to draw is that practically everywhere, with almost every species of planted or native tree, sooner or later some pest will cause serious injury. This season it may be one species, next season another. As climatic or other conditions change, native insects of which we know little become important, or immigrants come in and cause us the most trouble. Ten years ago we did not expect to be fighting our native Douglas fir tussock moth, Yellowstone sawfly, and spruce budworm, or the introduced elm leaf beetle, satin moth, and hazel scale. Tree lovers must be made to realize that if they would have satisfactory ornamental, shade, and recreational trees, they must spend a reasonable amount practically every year in fighting insect pests.

CORRELATION OF TEMPERATURES WITH HOST PLANT DEVELOPMENT AND DEGREE OF INFESTATION OF THE PEPPER WEEVIL, *ANTHONOMUS EUGENII* CANO, IN CALIFORNIA

By J. C. Elmore, *U. S. Bureau of Entomology*

(Paper not received)

DISTRIBUTION OF TWO SPECIES OF EPITRIX (COLEOPTERA) IN WASHINGTON

By R. L. Webster, *Washington State Agricultural College*

(Paper not received)

NOTES ON THE DISTRIBUTION AND ALTITUDE RANGE OF OREGON BREMIDAE (HYMENOPTERA)

By H. A. Scullen, *Oregon State Agricultural College*

Abstract

Twenty-two species and 15 varieties of *Bremus*, four species and one variety of *Psithyrus* have been taken in the state. Bumblebees range from sea level to the snow line, and are common in all parts of the state except the arid uncultivated sections. Several species are of considerable value in the red clover districts for pollenization purposes.

During the past eight years the writer has been collecting and studying bumblebees throughout most parts of the state of Oregon. These studies of Oregon bumblebees have been made, first, to determine what species we have present in the state, their geographical distribution and altitudinal range, together with their flora visiting habits. Secondly, we have been interested in studying them because of their value in the pollenization of certain commercial crops, especially that of red clover. So far twenty-two species and fifteen varieties of *Bremus* and four species and one variety of *Psithyrus* have been taken in Oregon.

Bumblebees can usually be found in abundance from sea level to the snow line on the higher mountains. Along the Oregon coast region and in the Coast mountains *B. vosnesenskii* (Rad.) and *B. mixtus* (Cr.) are abundant. Passing over into the Willamette Valley section where red clover is an important field crop *B. californicus* (Sm.) is probably the most important species. However, *B. mixtus* (Cr.) is also very abundant. *B. vosnesenskii* (Rad.) and *B. occidentalis* (Green) are

common. In the Coast Mountains *B. mixtus* (Cr.) and *B. vosnesenskii* (Rad.) are the more common in the lower sections of the mountains, while as we approach the higher altitudes in the coast mountains *B. melanopygus* (Nyl.) appears to be the more common. As we pass up into the foothills of the Cascades we find *B. occidentalis* (Green) becomes more and more common and at an elevation of 4000 to 5000 feet it is very abundant on the alpine flora. Associated with it and in equal numbers is *B. bifarius nearticus* (Hand.). As we go on up toward the snow line approaching 6000 feet and over *B. sylvicola* (Kirby) becomes the more common form.

Throughout the central desert region of eastern Oregon bumblebees are not common, but as we approach the mountains of eastern Oregon, they once more become abundant.

In the valleys of northeastern Oregon *B. hungii* (Green) becomes the more common although *B. falvifrons* (Cr.) and *B. occidentalis* (Green) are not at all uncommon. As one goes higher in the Blue Mountains *B. occidentalis* (Green) becomes far more common and at elevations up to 7000 feet is the most abundant. As one gets still higher and approaches the snow line, *B. sylvicola* (Kirby) begins to appear common.

The bumblebees have long been recognized as of great economic value in the pollenization of important agricultural plants. Outstanding among these is red clover, *Trifolium pratense* L. The role of bumblebees in the production of red clover seed has been studied by numerous investigators but more recently by Westgate and Coe (1915). These authors state (1915 p. 18): "Repeated field observations in Iowa in 1911 and 1912 showed that bumblebees were actively engaged in collecting nectar from eight to nine hours a day. Little work was done by them before the dew had entirely disappeared from the foliage and flowers or after six o'clock in the evening. Observations showed that bumblebees are able to pollinate 30 to 35 flowers a minute. However, they seldom visit more than eight to ten in a single head at one time." These same writers state (page 27) that in dry years "The honey bee proved to be as efficient a cross pollenator of red clover as the bumblebees— ."

The value of the annual red clover seed crop in Oregon is estimated at $500,000 by the Farm Crops Department of the Oregon State Agricultural College.

Bumblebees assist in the pollenization of other clovers, but as these are usually freely visited by the honey bee, the bumblebee is far less important than is true with the red clover. As a pollenizer of tree fruits, the bumblebee is of minor importance. The honey bee or even the

smaller *Andrenidae* and *Halictidae* are probably more frequent visitors. The work of Rawes and Wilson (1922, p. 16 and 17) in England, indicates that possibly bumblebees have not been given as much credit as they deserve for pollenization of apples. These writers state that bumblebees were "very important pollinators, keeping active in all kinds of weather, a few individuals having been observed at work during a snow squall."

If we were to suggest one species which might be encouraged and increased to assist in the pollination of the red clover crop of the Willamette Valley, this species would probably be *B. californicus* (Smith). Some effort has been made to get our native bumblebees to nest in artificial nests as described by Frison of Illinois, but with practically no success. A few nests of *B. californicus* (Smith) have been found above ground in old rags, etc. This would suggest a possible type of artificial nest which might prove attractive to them.

Observations so far seem to indicate that there is considerable variation from one year to another in the number of bumblebees available. The value of the red clover seed crop of the Willamette Valley would justify some effort in trying to work out some satisfactory means of providing an ample supply of pollenizing agents in the way of either bumblebees or longer tongued honey bees.

The writer is deeply indebted to Dr. Theodore H. Frison of the Illinois Natural History Survey for his assistance in determining most of the bumblebees collected in the state.

ALTITUDE RANGE AND DISTRIBUTION OF OREGON *Bremidae*

Bremus	Coast region	Cascades	East. Oregon
B. nevidensis (Cresson)	Rare		Uncommon 4,000 ft.
B. separatus (Cresson)	Uncommon		Uncommon 4,000 ft.
B. morrisoni (Cresson)	Uncommon		Uncommon 4,000 ft.
B. rufocinctus (Cresson)			Rare 2–4,000 ft.
B. rufocinctus iridis (Ckll. & Porter)			Very rare 4,000 ft.
B. rufocinctus prunellae (Ckll. & Porter)			Very rare 4,000 ft.
B. kirbyellus (Curtis)		8,000 ft.	
B. occidentalis (Green)	Common All elevations	Abundant To 5,000 ft.	Common 4–7,000 ft.
B. occidentalis proximus (Cresson)	Rare	Rare	Rare
B. frankloni Frison	2 specimens 500 ft.		
B. huntii (Green)	Very rare		Very common 2–4,000 ft.

B. huntii rufosuffusus (Ckll.)			Very rare
B. edwardsii (Cresson)	Very rare		
B. edwardsii russulus Frison		Very rare	
B. vosnesenskii (Redoszkowski)	Very abundant All elevations	Common to Rare	Rare
B. bifarius (Cresson)			Steans Mts. Rare 7,000 ft.
B. bifarius vancouverensis (Cresson)			Steans Mts. Rare 7,000 ft.
B. bifarius kenoyeri (Ckll.)			Steans Mts. Rare 7,000 ft.
B. bifarius nearticus (Handl.)		Abundant 4–5,000 ft.	Common 4–7,000 ft.
B. sylvicola (Kirby)		Rare 6,000 ft.	
B. sylvicola sculleni Frison			Uncommon 7,000 ft.
B. melanopygus (Nylander)	Common 0–3,000 ft.	Uncommon	Uncommon
B. melanopygus washingtonensis Frison		Mt. Hood 6,000 ft.	
B. sitkensis (Nylander)	Uncommon	Rare	Rare
B. caliginosus Frison	Rare		
B. mixtus (Cresson)	Abundant 0–4,000 ft.	Common to 4,000 ft.	Common
B. frigidus (Smith)	Rare		
B. flavifrons (Cresson)			Rare
B. flavifrons dimidiatus (Ashmead)	Rare	Rare	Rare
B. flavifrons ambiguus (Franklin)		Rare	
B. flavifrons vandykei Frison		Rare	
B. centralis (Cresson)			Common 4,000 ft.
B. appositus (Cresson)	Common 100–500 ft.	Rare	Common 1,000–4,000 ft.
B. fervidus (Fabricius)	Uncommon		Common 1,000–4,000 ft.
B. californicus (Smith)	Very abundant 0–4,000 ft.	Rare	Rare
B. californicus consanguineus (Handl.)	Rare	Rare	Rare
B. californicus dubius (Cresson)	Rare	Rare	Rare
Psithyrus			
P. insularis Smith	Uncommon	Rare	Uncommon
P. crawfordi Franklin	Uncommon	Rare	
P. suckleyi Green	Rare	Common 4,000 ft.	Rare
P. fernaldae Franklin	Uncommon		
P. fernaldae wheeleri (Bequaert and Plath)	Rare	Rare	

Literature Cited

Rawes, A. B. and Wilson, G. F. 1912. "Pollination in Orchards. VI. Pollen-carrying Agents." Jour. Roy. Hort. Soc., 47, No. 1; 15–17. (1912).

Westgate, J. N. and Coe, H. S. 1915. "Red Clover Seed Production: Pollination Studies." U. S. Dep. of Agric., Bull. 289.

NOTES ON THE INTRODUCTION OF THE WOOLLY APPLE APHIS PARASITE, *APHELINUS MALI*.

By LEROY CHILDS and D. G. GILLESPIE, *Hood River Experiment Station, Hood River, Oregon*

ABSTRACT

A survey of the apple districts of the Pacific Coast indicates that with one exception the woolly apple aphis parasite, *Aphelinus mali*, is non-existent or, at least, occurs in such small numbers no authenic records have been made with reference to its association with the woolly apple aphis. The insect occurs in limited areas at Vancouver, B. C., apparently the result of liberations made by R. C. Treherne in 1922.

The parasite was first introduced into the Hood River Valley in the late summer of 1928 from Fenville, Michigan. Other material was received from this area during 1929. The parasite has successfully passed two winters in the field and has thoroughly established itself at a number of points as a result of liberations made during the summer of 1929.

A complete life history is being made of the parasite. Seven generations of the insects occurred during 1929. It is still too early to predict to what extent Aphelinus will influence the control of the woolly apple aphis, it offers at least much promise as a factor along this line.

In view of the fact that demonstrations have shown the woolly apple aphis, *Eriosoma lanigera* (Hausman) to be definitely associated with the spread of perennial canker *Gloeosporium perennans* Zeller and Childs,[1] the suppression of the woolly apple aphis appears to be the key to successful canker control.

The woolly apple aphis does not respond well to control measures applied in the form of sprays due largely to the fact that it is an insect which seeks out areas more or less protected by overhanging bark. Where sprays are applied the insects survive in sufficient numbers to produce reinfestation of sprayed trees in a relatively short time even though exposed aphis have been effectively destroyed. Where canker diseases are present on apple trees the protected calluses upon which the woolly aphis is more inclined to feed are greatly increased and the problem of control is very definitely aggravated due to the protection offered. Large numbers of spraying tests and observations made where various types of contact insecticides have been used have demonstrated that the insects cannot be reached by known spray applications where they are located under overhanging bark areas.

In view of the fact that definite success has been obtained in the use of *Aphelinus mali*, the woolly apple aphis parasite, in Australia and New

[1]The Relation of Woolly Apple Aphis to Perennial Canker Infection with other Notes on the Diseases. Leroy Childs, Ore. Sta. Bul. No. 243, 1929.

Zealand following its introduction from the Eastern United States several years ago, an investigation of this insect was started in the summer of 1928 at which time the first parasites were introduced into the Hood River Valley from Fenville, Michigan.

DISTRIBUTION—WESTERN AMERICA. The senior author has been studying the relationship of the woolly apple aphis to perennial canker infection since 1924. Beginning with that year and extending up to the present time, practically all of the major apple sections of the Pacific Coast have been surveyed not only for the purpose of determining the range of canker infection but also for the purpose of observing the possible relationship of the aphis to canker infection.

This survey includes the following areas:—

BRITISH COLUMBIA:
- Western British Columbia
- Okanagan district

WASHINGTON:
- Western Washington
- White Salmon Valley
- Wenatchee
- Yakima

OREGON:
- Hood River Valley
- The Dalles-Mosier district
- Grande Rounde Valley
- Willamette Valley
- Rogue River district in Southern Oregon

CALIFORNIA:
- Yucapti
- Watsonville

In California several other minor localities have been examined along the highway from the northern boundary to the southern boundary where apple trees are grown. Several apple districts of Idaho and Montana have also been examined. The results of this survey indicate that *Aphelinus mali* does not occur in the apple districts of the Pacific Coast,[2] with one exception where E. P. Venables, in correspondence, states that he has found the parasite in a limited area in the vicinity of Vancouver, B. C., established apparently as the result of introductions made by Treherne in 1922. The presence of the parasite is easily detected on aphis infested apple trees. The black shells of the destroyed aphids persist for long periods of time and can be confused with no other condition. These persistent, black shells show the conspicuous exit holes of the parasite. As a result of our observations it would seem that reports of the occurrence of this parasite on the Pacific Coast are erroneous or at least to the effect that the insect's occurrence is extremely rare. The rapid increase the parasite has made at points of liberation in our study of the insects' behavior seem to substantiate the fact that it has not been present or its occurrence would have been

[2]Insects of Western North America, E. O. Essig, pg. 828.

definitely recorded. Concerning this point, Professor Essig writes as follows: "So far as I know this insect does not occur in California, although the insectary men and the specialists in the Bureau have indicated to me that the insect probably occurs throughout the range of its host. If it does occur in this state I have never seen either the insect or evidences of its work. I have done a good deal of work on woolly aphis in this region during the past ten years and have been on the lookout for the parasite but have failed to locate it. If here, it is in exceedingly small numbers."

With the exception of the area of occurrence reported by Venables, Colorado seems to be the western limits of *Aphelinus mali;* though at this time even this record appears questionable due to the fact that both Professors Gillette and List have for a long time been associated with insect control problems on apple and have never observed the parasite or its work in connection with the woolly aphis. Professor Gillette expresses the following in correspondence: "I do not find that we have any data at all concerning its attacking this aphid (woolly aphis). Our only notes concerning it are in connection with the melon louse, *Aphis gossypii.*" In a number of instances records of the occurrence of *Aphelinus mali* have been associated with aphids other than the woolly aphis as in the case of the Colorado record. Many of these records are doubtless due to faulty determination of the insect involved. Where careful breeding tests have been made with *Aphelinus* with a number of aphis species other than the woolly aphis no parasitism has been found to occur. The writers have attempted parasitism with a number of species reported as susceptible to attack but with negative results. At the present time Dr. Howard[3] is of the opinion that *Aphelinus mali* does not attack aphis other than those with waxy coverings. Additional study will doubtless further limit this generalization. At the present time the writers' very much question the occurrence of this species in Western America in areas other than the single instance cited. Negative reports have been received from entomologists located in New Mexico, Arizona, Washington, Idaho, Nevada and Montana.

INTRODUCTION OF PARASITE INTO HOOD RIVER. The parasite was first established in Hood River from collections made in Michigan by the senior author in August, 1928. The insects were placed in cages of the character used by Lundie[4] along with further material gathered in

[3]Howard, Dr. L. O. *Aphelinus mali* and its travels. Annals Ent. Soc. No. 3, Sept. 1929.

[4]Lundie, A. E. A Biological Study of Aphelinus Mali Hald. A Parasite of the Woolly Apple Aphid, Eriosoma Lanigera Hausm. Memoir No. 79 Cornell University.

Michigan by Mr. L. G. Gentner of the Michigan State College. Some reproduction resulted from the activities of the parasites, but for the most part, due to the advanced season, emergence from parasitized aphids did not take place. The parasites caged on apple trees in the orchard successfully survived the winter of 1928 which, however, was of rather mild character. From this material and further material, generously supplied by Mr. Gentner from time to time throughout the spring and summer of 1929, local colonies were built up to the point where field liberations could be made shortly after the first of July, 1929. From twenty-five to fifty parasites were liberated on apple trees well infested with the woolly aphis. The liberated insects at once began their egg-laying within the bodies of the aphis. On a tree where liberations were made July 5th parasites were observed emerging from aphids twenty days later. The parasites continued active during the remainder of the summer though it was observed that the period occurring from egg to adult very materially increased as the summer advanced. That the adult parasites remain active late in the fall is indicated by the fact that an adult was observed "stinging" an aphid as late as October 22, 1929. A check-up of the condition of aphid colonies was made in the experimental orchard late in the fall. Parasitized aphids were found at distances as great as twelve tree rows from the point of liberation; greatest advance was made in the direction of prevailing winds. At the present time, June 15th, 1930; parasites can be found at least twenty-five tree rows away from point of original liberation.

It is still too early to predict to what extent the parasite will play in the economy of the woolly aphis. In view of the fact the insect has successfully survived two winters in the field in the Hood River district (1929 reaching -19.5°) it is reasonable to suppose that temperature factors will not prove to be limiting ones. It appears promising in view of the fact that we observed the occurrence of approximately seven generations during the season of 1928 and the insect is now (June 14th) in its third generation. The parasite is not a prolific reproducer—on the other hand its most encouraging behavior is that of early emergence. The adult parasites were first observed on the trees in the orchard April 20, 1930, at a time when the first aphis activity was noted. This behavior enables the parasite to at least start off at "scratch" with its highly reproductive host.

From a biological standpoint it seems strange indeed, that *Aphelinus* had not long since been thoroughly established on the Pacific Coast unless some unknown ecological factors have been in operation to prevent its establishment and which will, in turn, perhaps prevent the

successful use of the insect through introduction. It is very difficult to account for the fact that the parasite was not introduced along with its host on apple stocks from Eastern United States. As a result of its overwintering habit within the body of its host—usually tightly attached to the plant—it would appear that natural transportation and introduction would have been easily accomplished not only once but many times. This does not seem to have been the case as our survey has shown. The ease with which we have thus far established the insect in the field tends to dispel our fears and it will now be necessary to wait until the species reaches saturation before its effectiveness can be expressed.

Friday morning session

The meeting was called to order at 9:30 A. M. by Chairman Mote, and the following papers presented:

A SEED CATERPILLAR ON A NATIVE CLOVER IN THE NORTH PACIFIC REGION (*GRAPHOLITHA CONVERSANS*)

By L. P. Rockwood and Sadie E. Keen, *U. S. Bureau of Entomology*

(Withdrawn for publication elsewhere)

NOTES ON THE DISTRIBUTION AND SPREAD OF THE DUSKY-VEINED WALNUT APHIS, *CALLIPTERUS JUGLANDIS* FRISCH., IN OREGON

B. G. Thompson, *Oregon State Agricultural College*

(Paper not received)

NOTES ON LABORATORY METHODS IN TEACHING ENTOMOLOGY

By Roland E. Demmick, *Oregon State Agricultural College*

(Paper not received)

ENTOMOLOGY AND THE ENGINEERS

By W. J. CHAMBERLIN, *Forest Entomologist, Oregon State College*

ABSTRACT

Data relating to wood defects caused by insects has been collected in the belief that such information would be of particular value to engineers, especially as the major loss develops in the manufactured or utilized wood rather than in the forest.

Of recent years so many inquiries have been received requesting information relative to damage inflicted by insects or their near relatives to timber, and timber products, that a course dealing with such groups is being offered at Oregon State College.

It is felt that the prospective forester or logging engineer might soon be so situated that he would be able to prevent considerable loss to employers by having information relative to such damage at hand. The structural and the highway engineer in their use of timber, the electrical engineer in handling poles, and other construction material, those concerned with ships, ship building and marine constructions and the architect may at any time be confronted with problems which call for a knowledge of particular groups of insects or near relatives, how they work and what may be done in the way of prevention and control.

An effort has therefore been made to collect all possible data pertaining to defects in wood caused by insects as well as injury to metals and other materials, and to incorporate this information so it might serve as a guide in the class room and the field.

Realizing that the engineer is not particularly interested in the animals themselves, no great amount of space has been devoted to the purely entomological side. A few pages of introduction to insects, their structure and general habits are given together with ample references where those interested may obtain further information.

The work of the author in connection with the various forest insect problems in the northwest for more than 15 years has been supplemented by consulting all available sources of information to gather the material. As would be expected, the publications of the department of Agriculture, Bureau of Entomology have furnished the main source of information, but state bulletins, entomological serials, trade papers and to some extent text books have been consulted and to all these thanks are due and acknowledgment is usually given in foot notes throughout the pages.

Ordinarily one does not associate engineering with any phase of entomology, yet engineers are constantly coming in contact with problems where the service and advice of the trained entomologist must

be procured unless special training along these lines has been obtained by the engineer.

To cite a few examples of where such training is of value we might point to the extensive damage wrought by termites to all classes of structural timbers in buildings, bridges, wharves, foundation and especially to poles. In fact, in the southern portions of the United States and in our Island possessions, as well as in most all tropical parts of the world, the damage inflicted by termites constitutes one of the major problems of the engineers.

In California a termite investigation committee, consisting of entomologists, zoologists, chemical and consulting engineers, together with representatives of such industries as railroad, lumber, telephone, oil, gas and electric companies, has been working since 1928 studying the extensive damage of these pests and attempting to work out suitable methods of practical control.

A large group of beetles, popularly known as powder post beetles, causes losses aggregating hundreds of thousands of dollars each year. These beetles not only attack native trees but commonly work in rough and finished products, even where materials have been placed in buildings. Cases of floors and roofs falling with resulting loss of life are not unknown. Some very interesting engineering feats have been performed in repairing and replacing materials destroyed by these insects. Much may be done to prevent this type of loss if those in charge possess the requisite knowledge.

Telephone engineers have been baffled by the work of a tiny beetle in California which amuses itself by boring through the lead sheathing of telephone cables. This work short circuits the lines in wet weather and results in interruption of service and entails expensive repairs.

The logging engineer should be conversant with the type and extent of damage to living, dying and recently dead trees; how damage may be prevented to saw logs; how long logs may be left in the woods without suffering too great an amount of deterioration; what insects attack piled lumber, to what extent, and how may this be prevented.

Near relatives of insects also cause a tremendous loss. A problem which many engineers have had to face was how may piling be protected from marine borers. These enemies in the sea, while not true insects, work in a manner similar to the latter and cause an enormous loss each year.

True there are many problems of the engineer and entomologist which still remain unsolved, but the former must have at least some knowledge of insects, what they are, how they live and work in order to intelligently attack problems where insects are concerned.

Attention will be given the principal types of defects in timber and timber products; a survey of the insects and near relatives causing such damage, and possible means of prevention or control.

AMOUNT OF LOSS IN FOREST PRODUCTS CAUSED BY INSECTS AND THEIR NEAR RELATIVES. Various estimates have been made of the amount of damage caused to forests and forest products by insects and allied forms of life.

This loss is extremely difficult to arrive at, with any great degree of accuracy, but if error has been made it is probable that it is in being too conservative. The lowest careful estimate is set at $150,000,000 each year. This loss is by no means confined to the class of material in which the engineer is interested. However, it is safe to say that fully one-third of the amount, or $50,000,000 would be a fair value of the loss inflicted on the products in which we are interested.

Losses in finished products are more expensive than to living trees in the forest. To illustrate: Bark beetles may kill a fine young Douglas fir tree and the loss is merely a few hundred feet of timber valued at say $3.00 per thousand feet on the stump. On the other hand, a similar tree is selected as suitable for a power line pole, it is cut, peeled, transported to the railroad, hauled possibly hundreds of miles and finally set in place, the power lines are affixed and it is serving a useful purpose. This pole no longer represents merely a nominal value of a few dollars, but to its original cost must be added the cost of harvesting, transporting and placing it in its ultimate position. It may now be attacked and in a very few months destroyed by termites, so that the company not only loses this pole but is forced to replace it at added expense.

From this example it may be seen that the destruction by one group of insects may be of little consequence in the forest, but if that same piece of material be destroyed after it has reached its ultimate destination, the loss is likely to be ten times as much in actual dollars and cents.

Damage by insects often goes unnoticed in the woods; especially is this true of certain groups which work in the heart wood of living trees, leaving little evidence of their work on the exterior surface. Such trees may be cut, transported to the mill and started through before the defects are discovered and they have to be discarded.

With proper training it is often possible to detect the greater portion of these trees in the woods and save a considerable sum for the operator by recognizing the damage early and avoid allowing the material to continue on through the various phases of manufacture.

Damage by insects to living trees cannot ordinarily be prevented, but from the time a tree is felled and cut into logs, it becomes increasingly

attractive to insects and from this point on practically all types of damage are preventable by various means which will be discussed in detail later.

Defects do not always necessitate the discarding of the whole material as worthless. Very often wood unfit for specialized uses may be employed for some other purpose where the requirements are not so exacting. All such material should be used when possible in order to avoid waste. Closer utilization of wood is an urgent need in the industries today in order that our diminishing supply of timber of all kinds may be made to hold out as long as possible.

Losses inflicted by marine borers (which are not insects) are not included in the $50,000,000 mentioned above. No very thorough survey of the damage by these creatures has been made for the whole country but statements made by reputable engineers and others for given localities serve to throw some light on the subject. As far back as 1896 an engineer of unquestioned standing, stated that the loss in the harbor at San Francisco alone was no less than $250,000. The Committee of the Marine Piling Survey Commission places the loss in the San Francisco Bay region during 1920–21 at more than $15,000,000.

The borers are active not alone in the San Francisco Bay region, but are reported from Sitka, Alaska, to San Diego, California on the Pacific Coast, and are also quite destructive in the harbors of the Atlantic States and in the Gulf of Mexico.

EXPERIMENTS IN KILLING EGGS OF THE CODLING MOTH ON HARVESTED FRUIT

By E. J. Newcomer, *Senior Entomologist, U. S. Bureau of Entomology*

Abstract

Codling moth eggs occurring on canning pears or early apples often hatch after the fruit is picked and sorted. The larvae from these eggs cause considerable injury to the fruit while it is ripening. It is not practicable to kill the eggs by means of cold storage, since it is usually desirable that the fruit ripen as rapidly as possible. Washing the fruit for removal of spray residue does not harm the eggs, but a treatment with dilute oil emulsion in a machine used for residue removal kills the eggs without retarding the ripening of the fruit or affecting its quality.

Codling moth eggs frequently occur on apples and pears when they are harvested, especially on summer or fall varieties, such as Yellow Transparent or Jonathan apples and Bartlett pears. This fruit is often kept at fairly warm temperatures for a time after harvesting. In particular, pears for canning are usually held at ordinary temperatures

in order to ripen them. During this time the eggs of the codling moth hatch and the larvae enter the fruit. As a result, fruit that is not more than 3 or 4 per cent wormy when picked may be 20 per cent wormy by the time it is ready for canning. An investigation was made in the Yakima Valley of Washington for the purpose of finding a means of preventing losses from this cause.

The possibility of killing the eggs with cold was first investigated. It is well known that cool temperatures greatly retard the development of codling moth eggs, and that the incubation period, which may be only five or six days in hot weather, may be increased to as much as three weeks by low temperatures.[1] Since the eggs are normally deposited only during mild weather, it was thought that they might be killed easily by chilling. In a preliminary test, apples upon which eggs had been deposited were immersed in a mixture of ice and water and held at a temperature of 36° F. for two hours. This had no significant effect on the hatching of the eggs, 14 per cent of them failing to hatch as compared with 10 per cent in a check lot held for a like period in water at 70°F.

Tests were then made by placing apples bearing eggs in various rooms of a cold-storage plant. As this plant was in use, and fruit was being carried in and out of the cold rooms at intervals, the temperatures varied somewhat. However, by means of thermographs, records of the actual temperatures were obtained. It is thought that the conditions of the experiment were similar to those that would obtain in commercial cold storage.

Eggs were held at temperatures of 35° to 38°F. and at 26° to 33°F. for one and two days; and at temperatures of 27° to 33° for one, two, three, and five days. The results of these experiments are given in Table 1.

While these experiments do not show the actual degree of cold necessary to kill all of the eggs, they do show that the use of cold storage is not feasible as a means of killing the eggs on cannery fruit. It seems probable that the fruit would have to be held in storage at the minimum temperature it would stand, that is 30° F.,[2] for at least ten days or two weeks in order to kill all of the eggs. This could not be done on account of the delay in ripening and the expense. In the case of packed or loose

[1]E. J. Newcomer and W. D. Whitcomb. Life History of the Codling Moth in the Yakima Valley of Washington. U. S. Dept. Agric. Bul. 1235, 1924. Table 30, p. 33.

[2]According to Wright and Taylor (The Freezing Temperatures of Some Fruits, Vegetables, and Cut Flowers, U. S. D. A. Bul. 1133) Bartlett pears and most varieties of apples will freeze between 28° and 30° F.

fruit going into cold storage for later consumption, there should be no trouble with infestation by larvae hatching from eggs on the fruit at the time it is picked.

From a scientific standpoint, it is very interesting that codling moth eggs will actually survive subfreezing temperatures for more than 100

TABLE 1. EFFECT OF COLD ON CODLING MOTH EGGS, YAKIMA, WASH., 1928

No.	Temperature °F.	Number of days	Total eggs	Number dead	Per cent dead	Number of larvae that entered fruit	Per cent of total eggs producing larvae entering fruit
1	36–38..........	1	363	82	22.6	184	50.7
2	35–38..........	2	325	49	15.1	176	54.2
3	26–30..........	1	246	66	26.8	127	51.6
4	26–30 (32 hours) 33 (16 hours)	2	239	61	25.5	113	47.3
5	27–31..........	1	250	41	16.4	139	55.6
6	27–31..........	2	235	65	27.7	108	46.0
7	27–30 (56 hours) 33 (16 hours)	3	298	130	43.6	95	31.9
8	26 (48 hours) 27–30 (56 hours) 33 (16 hours)	5	391	196	50.1	128	32.7
9	Check — normal temperature..		153	16	10.5	103	67.3

hours, as they did in experiment 8. There is a popular notion that frosty mornings will kill the eggs of the codling moth, but unless extremely cold temperatures are experienced on these mornings, apparently no such effect would be produced.

Since equipment is now available for mechanically and chemically washing fruit for the removal of spray residue, an experiment was made to determine whether this treatment could be used for killing the eggs of the codling moth that might be on harvested fruit.

Apples carrying eggs were washed by the two methods in most common use. In both of these methods the fruit is passed through a machine on a rod conveyor, being sprayed very thoroughly with the washing solution from above and below by means of a series of fan-shaped diffused sprays. The fruit is then conveyed through a similar spray of water. In one of these tests, a commercial alkaline solution, composed of a mixture of borax and sodium carbonate, was used at the rate of three-fourths pound to 1 gallon of water, and at a temperature of 110° F. The fruit was in the bath for 27 seconds, and was rinsed for 9 seconds. In the other test, a standard 0.67 per cent solution of hydrochloric acid was used at a temperature of 70° F., the fruit being in the

bath and rinse for 55 seconds. A slightly higher percentage of eggs failed to hatch on both lots of washed fruit as compared with eggs on unwashed fruit. Possibly this was due to injuries sustained in handling the apples. However, from two-thirds to three-fourths of the eggs on the washed apples produced larvae which later entered the fruit. The treatment was therefore of no value.

Attention was then given to the use of oil emulsion, such as is employed for spraying fruit trees, in one of these machines. Through the cooperation of the Oregon Packing Co., a quantity of Bartlett pears was run through a standard fruit-washing machine holding 200 gallons of oil emulsion. The pears were carried through the machine on a rod conveyor and were sprayed very thoroughly from above and below with the emulsion. They were not rinsed or dried, but were carried immediately to lug boxes. It took approximately one minute for individual pears to pass through the machine.

Three summer oil emulsions, containing light, medium, and heavy oil, respectively, and one dormant oil emulsion were tested. These emulsions contained approximately 83 per cent of oil and they were tested at various strengths, with and without casein spreader, as shown in Table 2. Fruit carrying codling moth eggs was treated in six of the ten tests. In the five tests of summer oil emulsions (Nos. 1, 3, 4, 7 and 8) none of the eggs hatched; in the test with dormant oil emulsion 96 per cent of the eggs failed to hatch; whereas in the check only 11.2 per cent of the eggs failed to hatch. No observations were made on eggs in the tests where casein spreader was added, but data previously acquired, which have not yet been published, show that the addition of casein spreader to an oil emulsion has no appreciable effect on its ovicidal value. Evidently any of these emulsions may be used in this manner, without spreader, at the rate of 1 gallon of emulsion to 100 gallons of water (0.8 per cent actual oil) to kill codling moth eggs.

In order to find out whether the oil emulsion would in any way affect the quality of the pears or the time needed to ripen them, ten lug boxes of fruit from each test were subjected to the usual ripening treatment employed by the cannery. The fruit was simply held in the lug boxes at ordinary temperatures, which ranged from 70° F. to over 90° F. At the end of nine days some of the fruit was ripe enough to can, and the whole lot was sorted and the ripe fruit and green fruit weighed. In this manner an indication of the relative rate of ripening in the various lots was obtained.

The last column in Table 2 shows the percentage of ripe pears nine days after treating with oil emulsion. In spite of considerable variation in the results, it is apparent that ripening was delayed somewhat by the

TABLE 2. EFFECT OF TREATING PEARS WITH OIL EMULSIONS IN FRUIT-WASHING MACHINE, YAKIMA, WASH., 1929

No.	Treatment	Viscosity of oil (Saybolt at 100°F.)	Unsulfonated residue, 37N sulfuric acid	Number of codling moth eggs examined	Per cent eggs dead	Per cent fruit ripe 9 days after treatment
			Per cent			
1	Light summer oil (miscible), 0.8 per cent oil...........	53	90	175	100.0	46.3
2	Do., 0.8 per cent oil; casein spreader, 1 pound to 200 gallons..................	53	90	—	—	66.2
3	Medium summer oil (emulsion), 0.8 per cent oil.......	82	92	273	100.0	28.7
4	Do., 1.2 per cent oil..........	82	92	7	100.0	33.8
5	Do., 1.6 per cent oil..........	82	92	—	—	51.1
6	Do., 1.6 per cent oil; casein spreader, 1 pound to 200 gallons..................	82	92	—	—	40.2
7	Heavy summer oil (emulsion), 0.8 per cent oil............	130	95	33	100.0	20.2
8	Do., 1.2 per cent oil..........	130	95	84	100.0	28.9
9	Do., 1.2 per cent oil; casein spreader, 1 pound to 200 gallons..................	130	95	—	—	63.3
10	Dormant oil emulsion, 0.8 per cent oil..................	106	70	75	96.0	65.6
11	Check.....................	—	—	134	11.2	61.9

summer oils, and that less delay was caused by the light oil than by the heavier oils. The dormant emulsion had no effect on ripening. The slight delay apparently caused by the oil is of no practical significance.

Pressure tests of the pears were also made, but the individual fruits varied so much that these tests were of no value.

CONCLUSIONS

1. Cold-storage temperatures of 26° to 33° F. for five days kill about 50 per cent of codling moth eggs deposited on fruit. Probably similar temperatures for at least ten days or two weeks would be necessary to kill all of the eggs.

2. The eggs are not killed by the usual washing treatment for removal of spray residue.

3. Codling moth eggs on cannery fruit may be killed by spraying the fruit with oil emulsion in a machine used for spray-residue removal. A light summer or dormant type oil emulsion should be used containing about 1 per cent of actual oil. The fruit should not be rinsed and it is not necessary to dry it in warm weather. No bad effects result from this treatment. If it is desired also to remove the spray residue, as in the case of fruit that is to be packed, this should be done first, followed by the oil-emulsion treatment.

CODLING MOTH ACTIVITY IN THE WENATCHEE VALLEY AS SHOWN BY TRAP RECORDS

By ANTHONY SPULER

ABSTRACT

Bait traps have served as efficient indicators of codling moth activity in the apple orchards of the Northwest. Trap records taken from various sections of the Wenatchee valley show that there is a marked similarity in moth activity in all parts regardless of temperature conditions. Such factors as soil type, cultural practices, cover crops and exposures are of relative unimportance in determining the time when the moths become active and deposit eggs in the orchards. Moth activity is approximately the same in widely separated locations and under totally different conditions.

The use of bait traps as indicators of codling moth activity in orchards was reported in 1926.[1] Since that time the traps have been utilized by a large number of growers as a means of determining spray dates. In almost every case where the traps have been so used growers have reported them of value in giving them information on the time and relative abundance of moth flight and oviposition. It has been generally recognized that the codling moth deposits but few eggs unless temperatures at dusk are near 60 degrees Fahrenheit. Trap records show that relative few moths are caught in the traps unless temperatures at dusk are favorable for egg-laying. The moth catch in the bait traps is, therefore, an indication to the grower that eggs are being laid in the orchard. Since bait traps catch large numbers of moths, often as high as 50 moths per trap per night, they serve remarkably well for this purpose.

Prior to the use of bait traps for determining spray dates it was assumed that each particular orchard presented conditions which affected emergence and egg-laying of the codling moth. It was thought that different soil types, absence or presence of a cover crop, types of tree growth, exposure to the direct rays of the sun and locality were important factors which so affected codling moth activity that it was necessary to spray at different times for each condition or locality.

A study of moth trap records in various orchards in the same and different localities have been made during the past four years and it appears that these factors are relatively unimportant in planning a spray program. In fact the trap records indicate that codling moth oviposition is so little affected by orchard conditions that information regarding the time when young worms are likely to begin entering the fruit can be secured by some centrally located individual in a district. Of course it will be necessary for each grower to keep trap records to

[1]Proc. Wash. State Hort. Soc. Rept. 1926.

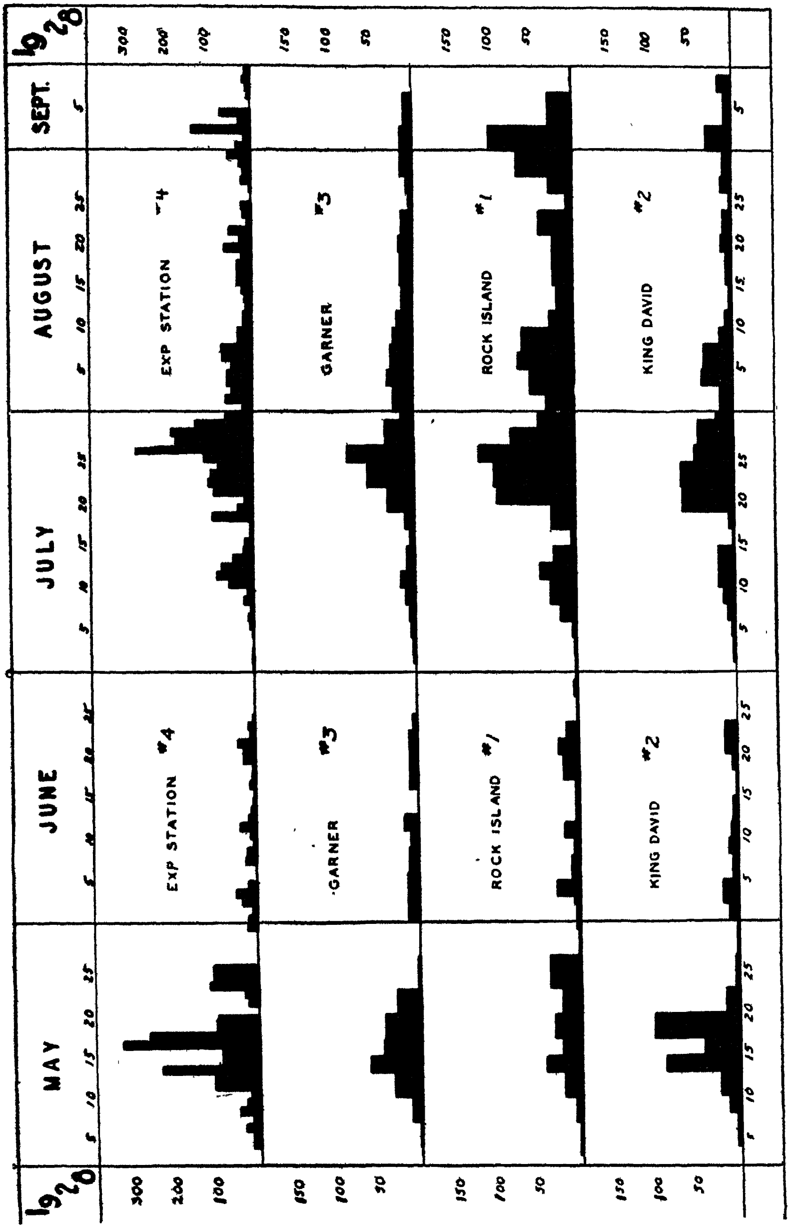


FIG. 68.—Trap record in four orchards for 1928.

determine the relative abundance of moths in his particular orchard for this will vary according to the degree of infestation the year before and the thoroughness with which the sprays are applied.

In 1927 and again in 1928 a series of bait trap tests were conducted in four orchards to determine what effect such factors as soil type, cover crop, exposure and locality had on the activity of the codling moths. Each of the four orchards presented a combination of conditions different from the other three. Orchard number one was located at Rock Island in one of the warmest localities in the Wenatchee Valley. This particular orchard had a western exposure, the trees were small, affording but little shade to the soil, the soil was very sandy and had no cover crop. All of these conditions favored high temperatures for the hibernating larvae in the soil at the base of the tree or on the tree itself.

Orchard number two was located north of Wenatchee and about twelve miles from the first orchard. This orchard contained fairly large trees but these were not crowded, the soil was slightly sandy and was clean cultivated. The orchard had a southern exposure. Temperatures in this orchard were high but not as high as in orchard number one. Orchard number three was located south of Wenatchee, contained large crowded trees, a heavy soil and heavy cover crop. This orchard had a northern exposure and the lowest temperatures of the four tested. The last orchard was the experimental orchard located near Wenatchee. This orchard had a heavy soil, large trees, a poor cover crop and an eastern exposure.

Ten traps were placed in each orchard and regular inspections made. The results of the moth catch in these traps are shown in figure 68.

It will be noted that moths were first caught in numbers in all of the four orchards on approximately the same day. From that time on the catch is not continuous but during the spring month is largely influenced by evening temperatures. However, the fluctuations in numbers caught are the same in all of the orchards and even continue thru the second brood activity when evening temperatures are not a factor, since temperatures at dusk during July and August were rarely below 60 degrees.

Moth trap records do not give information on the actual emergence of the codling moth since the moths may emerge and because of unfavorable weather for flight or oviposition remain inactive for some time. It is quite likely that moths in the warmer locations emerged before the others but because of unfavorable evening temperatures were not caught in the traps until some time later.

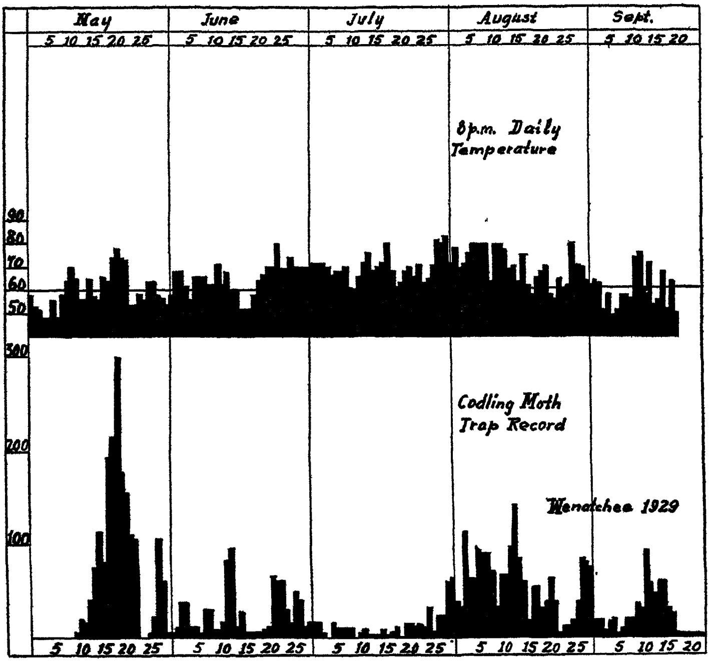


FIG. 69.—Trap records in experimental orchard Wenatchee 1929.

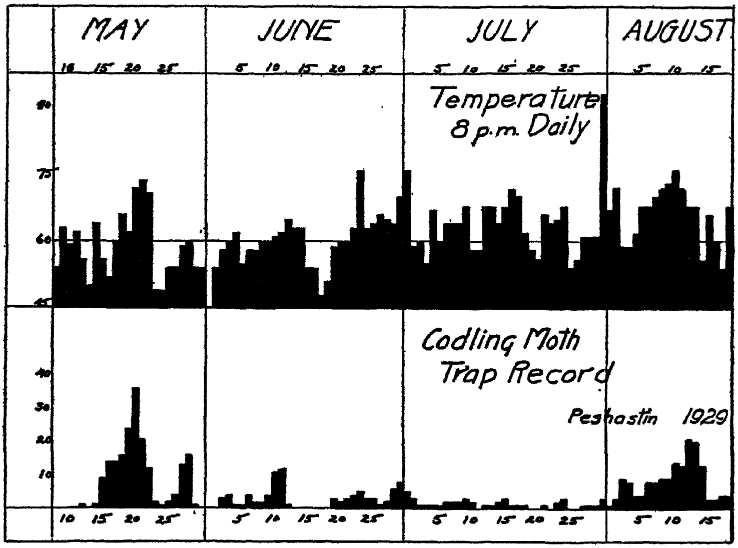


FIG. 70.—Trap records in representative orchard at Peshastin (1929).

A study of the temperature records in the four orchards show considerable differences in maximum and mean daily temperatures. However, when temperatures at eight o'clock in the evening are compared it will be noted that during May and June these fluctuate above and below the 60 degree mark at approximately the same time. In other words periods of warm temperature extend over the entire valley at the same time and usually bring temperatures above 60 degrees at dusk even in the colder parts of the valley. As stated before, moth emergence is earlier in the warmer locations and this is reflected in the traps when temperatures are favorable for flight, by larger catches.

Temperature has been regarded as one of the chief factors in codling moth development. While temperature is certainly an important factor in insect development it certainly is not the only important one affecting the development of the codling moth. In referring again to Fig. 68, it will be noted that the moth catch in the warmest orchard extended over the longest period of time in the spring. It has generally been believed that under favorable temperature conditions the moth emergence in the spring would be rapid and over a relatively short period of time. In comparing the results of the trap tests in the four orchards during July, August and September, it will be noted that the same fluctuations exist in all four orchards thruout the season. This seems to hold true regardless of evening temperatures.

Thru the courtesy of Mr. Geo. Harter, Supervisor of Horticulture, State Department of Agriculture and Mr. Robert Campbell, District Horticulture Inspector at Wenatchee, it was possible for the writer to obtain moth trap records in all the various parts of the Wenatchee Valley. It would not be possible to present all this material in a paper of this kind because of limited time. However, a general idea of the moth activity in different parts of the valley can be obtained from the records of two orchards presenting entirely different conditions. These are shown in Figures 69 and 70.

Wenatchee is located in the warmer portion of the Wenatchee Valley. Trees come into bloom in this district about a week earlier than in the Peshastin district which is in the upper part of the valley. A comparison of the records in Figure 69 with that of Figure 70 shows a similarity which is quite marked.

The chief differences in the record of the two localities is in the number of moths caught in the traps. At Wenatchee the calyx spray is applied a week earlier than it is at Peshastin yet the time of general moth flight in the two districts is approximately the same. The calyx spray in the Wenatchee district is often applied before many moths are caught in

the traps and a cover spray is necessary to take care of the general activity later on. In the Peshastin section the moths usually fly and lay eggs at the time the calyx spray is applied and this spray takes the place of a first cover. Trap records in all of the upper portion of the Wenatchee Valley, the Chelan district and the Okanogan and Oroville sections show a low moth catch. In none of these sections is the codling moth a serious pest. In the lower Wenatchee Valley the moth catch is relatively large and usually comes at a time when fruit has attained considerable size. This is a factor in control since the codling moth begins to lay her eggs on the fruit as soon as it shows considerable size and the newly hatched worm has less opportunity of becoming poisoned than if forced to travel from the leaves or twigs to the fruit. Comparisons of trap records in districts as widely separated as Wenatchee, Wash., Yakima, Wash., and Parma, Idaho show that moth activity thruout the summer is approximately the same in all of them.

As previously stated the codling moth may emerge some time before favorable weather induces it to fly and enter the traps. However, continued entry into the traps must to some extent at least be dependent on moth emergence, since the average life of the moths in the orchard is not very long.

In 1929 the trunk of a living tree was caged as shown on plate 30 and stocked with approximately 1400 larvae, all of which were taken from tree bands within a period of two weeks. This was done to determine how long it would take for all the worms in a cage to emerge. The worms were allowed to enter the soil or hibernate under the bark of the trunk. Moths began to emerge in this cage on the 30th day of April and are still emerging at the rate of 15 to 20 a day at the time this paper was prepared (June 15). The temperatures during the past winter have been very low and for a few days reaching 19 degrees below zero Fahrenheit. As a result there was a rather high mortality in the hibernating worms. At the writing of this paper over 300 moths had emerged. As far as could be determined all of the larvae in the cage were subjected to approximately the same temperature conditions yet emergence from the trunk and soil has continued almost two months and may continue for some time yet.

The trap records are proving to be of greater value to the grower than the older method of caging larvae, since they are based on actual moth flight and oviposition under natural conditions in the orchard. The grower is not directly concerned with the time of emergence of the codling moth but is vitally interested in the time the moth is laying eggs in the orchard. As shown by the trap records oviposition may be delayed for a

Codling moth cage about base of apple tree.

considerable period and many moths may emerge and lay relative few eggs because of unfavorable weather.

The bait traps show that moth activity is not uniform thruout the season but appears to fluctuate up and down and most of the eggs in both first and second broods are laid in a relatively short period of time. This information is of great value when ovicidal sprays such as oils or nicotine compounds are used.

CONTROL OF THE EARWIG BY THE EUROPEAN GROUND BEETLE, *PTEROSTICHUS VULGARIS*

also

CONTROL OF THE EUROPEAN BROWN SCALE BY CHALCID PARASITES

By Trevor Kincaid, *University of Washington, Seattle, Wash.*

(Papers not received)

EXPERIMENTS WITH BAITS FOR STRAWBERRY ROOT-WEEVILS IN OREGON

By J. Wilcox and Don C. Mote, *Oregon State Agricultural College*

(Paper not received)

THE USE OF PINE TAR OILS AS INSECTICIDES AND FUNGICIDES

By E. R. de Ong

(Paper published elsewhere)

RESULTS OF AIRPLANE DUSTING IN THE CONTROL OF COTTON BOLL WORM (*HELIOTHIS OBSOLETA* FAB.)

By Franklin Sherman, *Department of Entomology, Cornell University*

Abstract

Large scale airplane dusting operations in the Brazos River Bottoms near College Station, Texas, in 1927 indicated that boll weevil might be successfully controlled by the use of from five to six pounds of calcium arsenate per acre. Boll worms however, were not controlled and increased on the dusted area throughout the season. General observations indicated that more boll worm damage appeared on the heavily dusted cotton than on the untreated areas.

During the summer of 1927 a large acreage of cotton was dusted by airplanes in the Brazos River bottoms of Texas. The purpose of this dusting was to control three important pests of cotton, the boll weevil, the cotton leaf worm, and the cotton bollworm.

Throughout the dusting period the writer was engaged in close observations of the results obtained on the J. O. Chance plantation, located in Burleson County, Texas.

The results obtained in controlling the boll weevil, of which there was a very heavy infestation, have been published in The Texas Experiment Station Bulletin 394. Table 1 summarizes the reduction in boll weevil infestation secured by dusting and Figure 71 illustrates this diagramatically.

Poison Applications. From five to six pounds of calcium arsenate was applied per acre. Applications were made mostly in early morning when plants were wet with dew. Airplanes used were furnished by Huff-Deland Dusters, Corp., and the pilots were men experienced in cotton dusting. Three applications were made on all of the dusted areas and on heavily infested portions, four applications were made.

General Conditions. The Chance plantation is located on the west bank of the Brazos River, extends back from the river about four and one-half miles, and consists almost entirely of river bottom land. Slightly less than 3,000 acres were planted in cotton. Scattered here and there throughout the large cotton fields were numerous small fields of corn. Since the owner greatly feared bollworm damage, numerous counts were made in early June to determine the abundance of *H. obsoleta* in corn. At this time practically every ear was infested with one or more larvae. When dusting operations began on July 14, close observations were made on the activities of the bollworm on the dusted areas of cotton.

METHODS OF OBSERVATION. Before the first application of dust a survey of the infested area showed that 30.2 per cent of the squares were being damaged by boll weevil. At this time there was little evidence of bollworm damage. Certain plants were selected at various areas throughout the acreage in cotton. After each application of poison 100

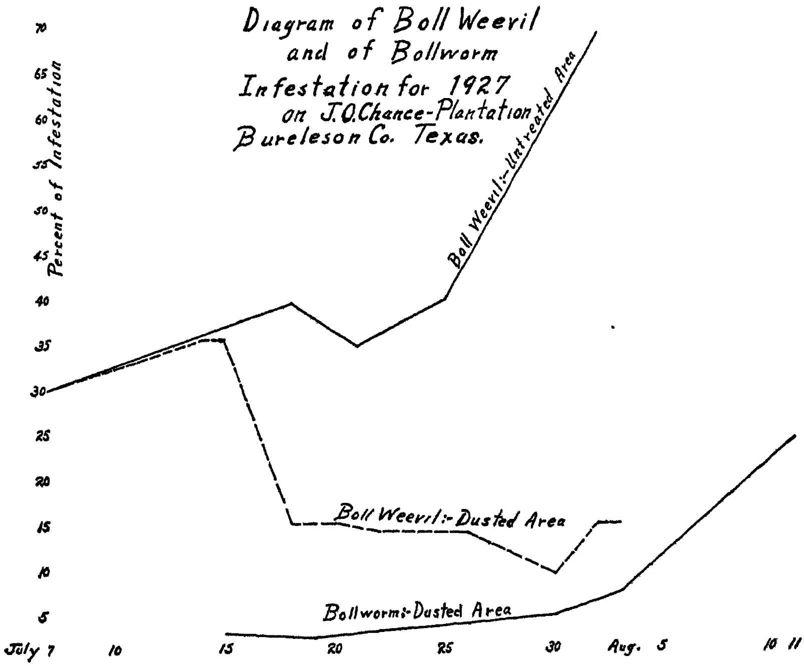


FIG. 71

squares were examined on the selected plants at the different points. Records were taken at the time of each examination for boll weevil and bollworm damage. The records on August 11 were taken on bolls only, since very few squares were present at this time. The untreated area was a ten acre field left as a check to be used in comparison with the dusted area.

RESULTS OF THE DUSTING. The following table presents a summary of the infestation data secured during the course of the summer. Figure 1 represents diagramatically the boll weevil infestation on treated and untreated areas, and the bollworm infestation on the treated area. Since but little bollworm infestation developed on the ten acre check infestation data is not included for this area.

TABLE 1. SUMMARY OF BOLL WEEVIL AND BOLL WORM INFESTATION DATA

Places Examined	Dates Examined	No. squares Examined	Percentage of Infestation Mean	Max.	Min.	
21	July 14–15	2100	36.9	62.0	21.0	Boll Weevil Infestation Data: Dusted Area
30	July 18–20	3000	15.3	38.0	2.5	
30	July 22	3000	14.6	24.0	1.5	
30	July 26	3000	13.4	18.5	1.5	
18	July 30	1800	10.0	39.0	2.0	
30	Aug. 2–3	3000	15.3	42.0	4.0	
12	July 18	1200	39.8	62.0	28.0	Boll Weevil Infestation Data: Undusted Area
12	July 21	1200	35.2	58.0	17.0	
12	July 25	1200	40.5	64.0	14.0	
12	Aug. 2	1200	69.1	86.0	47.0	
9	July 15	900	2.1	7.0	0.0	Boll Worm Infestation Data: Dusted Area
18	July 18–19	1800	1.4	4.0	0.0	
18	July 22	1800	2.7	7.0	0.0	
18	July 26	1800	3.5	9.0	0.0	
18	July 30	1800	5.2	12.0	1.0	
18	Aug. 3	1800	10.5	23.0	0.0	
18	Aug. 11	1800	24.5	43.0	1.0	

DISCUSSION OF RESULTS. A study of the figures presented in Table 1 and of the curves presented in Figure 71, clearly indicates that no practical control was secured over the bollworm by dusting with calcium arsenate. At all places where infestation was observed, when dusting began, the infestation continued to increase in spite of dusting. Not only was this true where calcium arsenate was applied by airplane, at from five to six pounds per acre, but it was equally true on certain demonstration plots, where every care was taken to secure thorough dusting and where as much as twelve pounds of calcium arsenate per acre were applied. One such plot was dusted at five day intervals from June 29th to July 30th. In this plot boll weevil infestation was high when dusting began but was so controlled by the dusting that bolls formed to the very tops of the plants. However, bollworm damage continued and by August 10th many bolls saved from the boll weevil were ruined by the bollworm. On this plot, dust applications began before eggs, larvae, or adults of bollworm were observed in cotton although hundreds of plants were examined each day during June.

UNUSUAL TYPE OF DAMAGE. In addition to the usual types of damage, the writer observed nearly grown larvae of the bollworm in the act of cutting off from four to six inches of the terminal portion of the cotton plants by feeding in the stem. This form of damage was common in a heavily infested field of young cotton on July 13th. So far as the writer knows this type of damage had not been reported in the field, although it is reported as having occurred where many larvae were confined on plants covered by cages. (U. S. D. A., Bulletin 50, Bureau of Entomology.)

GENERAL OBSERVATIONS. Since bollworm damage was so severe on certain portions of the dusted plantation, the writer made numerous observations to determine whether this damage was as severe on undusted plantations. While these observations were of a superficial nature it is believed that they were numerous enough to be of value. It appeared without exception that bollworm damage was heaviest on the areas that had been dusted or in nearby fields. No attempt is made to explain this infestation but nevertheless in places the evidence seemed striking. In addition to these observations concerning this point the writer wishes to state that in a conversation with Mr. R. K. Fletcher, Entomologist of The Texas Experiment Station, he was informed that the same condition seemed to occur during the summer of 1928 although at this time the dusting was much less extensive than during 1927.

SOME FACTORS AFFECTING THE INFESTATION OF ORIENTAL FRUIT MOTH

By S. W. FROST, *The Pennsylvania State College*[1]

ABSTRACT

The infestation of *Laspeyresia molesta*, where several varieties of peach are grown together, is discussed in relation to certain factors as: twig growth, fruit growth, abundance of fruit, temperature, precipitation, etc. Twig growth, abundance of fruit and broods determine more than any other factor the nature of the infestation.

It has long been suspected that certain factors contribute to the abundance and distribution of the oriental fruit moth but no definite figures are available, up to the present time, to verify this. During the summer of 1929 an attempt was made to gather data bearing on this point and some preliminary figures are given. A number of factors that seemed to have some bearing on infestation were taken into account. These can be divided into two classes: (A) Factors uniform for all varieties; (B) Factors varying in different varieties. To class A belong: temperature, precipitation, other weather conditions, broods, parasitism etc. To class B belong: initial infestation, location (nearness to packing shed or edge of orchard), twig growth, fruit growth, ripening and picking of peaches, abundance of fruit and the possible susceptibility of different varieties.

[1]Publication authorized by the Director of the Agricultural Experiment Station as Technical Paper No. 498.

TABLE 1. COMPARISON OF TWIG GROWTH AND TWIG INFESTATION, ADAMS CO., PA., 1929

Variety	June 1 Twig growth	June 1 Twig infest	June 10 Twig growth	June 10 Twig infest	June 17 Twig growth	June 17 Twig infest	July 2 Twig growth	July 2 Twig infest	July 18 Twig growth	July 18 Twig infest	July 30 Twig infest	Aug. 15 Twig infest	Total Twig infest
Hiley[1]	4.9	7	5.3	47	6.1	28	8.8	34	10.1	129	23	13	281
Hiley[2]	5.1	1	7.7	12	10.9	11	14.4	49	20.6	133	49	47	302
Belle Georgia[2]	6.7	4	6.4	17	7.8	7	17.8	45	15.7	148	58	18	297
Hale[1]†	4.0	8	4.3	43	4.8	24	10.1	37	12.0	224	80	13	429
Hale[1]*	4.9	6	5.2	26	7.0	19	8.5	27	10.4	134	31	12	255
Hale[2]	6.9	3	9.5	21	13.8	20	21.5	34	25.8	147	79	46	350
Early Elberta[1]	4.0	11	4.0	50	6.1	26	10.3	37	13.4	158	57	19	358
Early Elberta[2]	5.3	2	4.9	10	6.1	3	12.0	24	14.4	72	34	23	168
Late Elberta[2]	5.4	26	5.9	115	5.2	11	6.4	64	7.8	125	14	7	362
Krummel[1]	1.8	1	1.9	44	2.9	12	2.9	5	3.5	14	9	7	92
Total twig infestation		69		385		161		356		1284	434	205	2894

Legend—Twig growth measured in Cm. Infestation = number injured terminals. [1] old trees. [2] young trees. †unpailed trees.
*pailed trees.

An orchard of 10,000 bearing trees was selected where different varieties, including both young and old trees, were growing together. Infestation was determined by clipping injured twigs, gathering and examining fruits and by means of bait-traps.

TWIG INFESTATION. The twig infestation was determined by clipping all infested terminals about once a week from five trees located near the middle of each variety, using the same trees each week and employing ladders to reach the tops of the trees. During 1929 the infestation was unusually low. The first infested twig was seen on May 28th but they were not abundant enough to be noticeable until June 1. Twig infestation continued until August 15th, after which injured terminals became scarce. The infestation was generally greatest upon the young trees. The highest infestation (429 terminals) occurred in a block of unpailed Hale adjacent to a similar block of Hale which was pailed and showed an infestation about half as great (225 injured terminals). Twig infestation was lowest (92) in the Krummel block where twig growth was least. There were no dehorned trees during 1929. Such trees always show high twig infestation.

It is evident that twig infestation continued rather strongly after the terminals had hardened (about July 15th), although the maximum twig infestation occurred about June 10th, shortly after the initial infestation.

Figures taken during 1928 on dehorned Late Elberta in the same orchard show somewhat higher infestation. Infested twigs were collected from twenty-three dehorned trees as follows.

TABLE 2. INFESTED TERMINALS CLIPPED FROM 23 DEHORNED ELBERTA, 1928.

Date	No. Infested terminals	No. worms recovered	
June 6	150	61	
" 8	200	60	
" 11	125	36	
" 13	70	22	Brood I
" 20	60	6	
" 28	20	3	
July 3	12	0	
" 12	582	174	
" 16	233	78	
" 17	401	75	Brood II
" 20	298	78	
" 23	198	35	
" 31	172	12	
Aug. 2	135	8	
" 9	147	55	
" 15	270	86	Brood III
" 21	388	88	
" 28	190	22	
Totals	3651	899	

TWIG GROWTH. Measurements were made in the orchard, in centimeters, about once a week of fifty terminals taken at random from trees near the centers of the blocks shown in Fig. 72. No water sprouts, suckers or injured twigs were measured. Growth was well under way by June 1 and the twigs hardened about July 15, this varying somewhat in the different varieties. Belle of Georgia reached maximum growth about July 2. Twig growth in the Krummels was noticeably small throughout the summer.

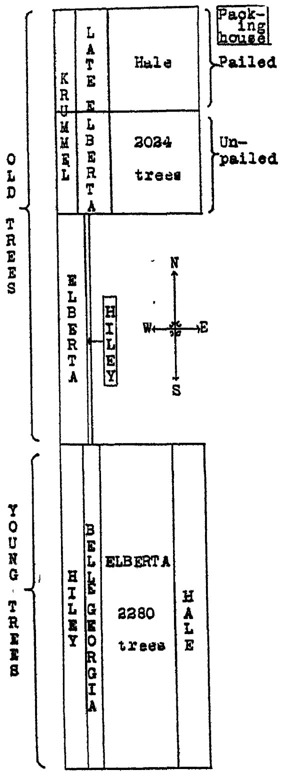


FIG. 72.—Diagram of Experimental Orchard.

FRUIT INFESTATION. One hundred fruits were taken once every other week from trees near the center of each variety. These collections were made from June 10th until July 30th, when the orchardist finished his thinning and it was not practical to take further fruits. To avoid personal judgment in selecting the fruits, the following rules were adhered to: when three fruits hung close together on a branch, the middle fruit was always selected; when two or more fruits hung adjacent, the right-hand fruit or fruits were selected.

All of the fruits (1000 at each collection) were taken to the laboratory and placed in battery jars with strips of corrugated paper and covers of cheesecloth. Daily records were made of the larvae, pupae and adults found in the jars. This method was continued for each collection of fruit for three or four weeks so as to be certain that all of the oriental fruit moths had emerged. It was found more accurate than cutting fruits, especially when the fruits were small and green and when the larvae were minute.

Records were also made of the curculio infestation in a similar manner. The results are summarized in the following table.

It is evident from Table 3 that curculio injury upon peaches hanging upon the trees became less and less until at picking time the percentage approximated zero. The loss from curculio, therefore, is not entirely evident in the picked fruit. The greatest curculio infestation occurred

TABLE 3. PERCENTAGES OF CURCULIO AND ORIENTAL FRUIT MOTH INJURY, ADAMS COUNTY, 1929

Variety	Date	O. F. M.	Curc.	No. of fruits
All*	June 10	.8	14.0	1,000
All*	" 27	1.0	10.0	1,000
All*	July 10	1.5	5.0	1,000
All*	" 30	3.0	1.5	1,000
Hiley	Aug. 6	8.0		400
Krummel	Sept. 26	25.5		1,000

*Includes: Belle of Georgia, Hiley, Hale, Elberta and Krummel.

on a few trees adjacent to a brush pile where conditions were favorable for their development. On August 6th, a few Hiley trees under such conditions showed 25 per cent curculio injury while the average for the whole orchard was less than 1 per cent.

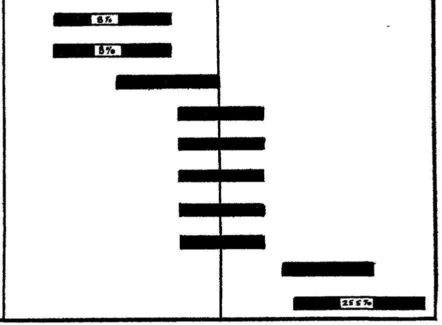
FRUIT GROWTH. The fruits gathered for records of infestation were weighed and measured, length and diameter in centimeters, as soon as they were brought to the laboratory. Only the weights are shown in Table 4. A complete record of fruit growth is given in Table 5.

BAIT TRAPS. One hundred bait traps were arranged throughout the orchard in the different varieties to give an idea of the distribution and abundance of moths during the summer. Ten traps were placed near the center of each variety. The baits were all mixed at the same time and the traps were set on the same day. They were replenished four times during the season in order to keep them in prime condition, and they were examined once a week and the catches were taken to the laboratory for study and counts. The figures show that the moths were flying during early summer among the old trees on the north side of the orchard and during the late summer among the young trees towards the south end of the orchard. This is probably due to the fact that the larvae winter over largely on the older trees, especially the late variety Krummel, at the north end of the orchard. The packing house at the northeast side of the orchard also helps to explain the difference in moth population.

In addition to the bait traps, 1,000 pails were hung in the varieties Hale, Late Elberta and Krummel, placing a pail on every other tree in every row as indicated in the diagram of the orchard (Fig. 72). These baits were set on April 15th and were replenished on June 1st, receiving no further attention during the remainder of the season. Some apparent effects of these baits may be seen when the pailed and unpailed blocks are compared with respect to terminal injury (Table 1) and captures from bait traps (Table 6).

TABLE 4. COMPARISON OF FRUIT GROWTH AND FRUIT INFESTATION, ADAMS CO., PA., 1929.

	JUNE				JULY				AUGUST 1 7 14 21 28 / SEPTEMBER 1 7 14 21 28
	10		27		10		30		
Variety	Fruit weight	Fruit infest	Fruit weight	Fruit infest	Fruit weight	Fruit infest	Fruit weight	Fruit infest	Periods of ripening.
Hiley[1]	14.4	1%	32.0	1%	41.0	6%	68.5	2%	8%
Hiley[2]	17.0	0	34.0	1%	34.0	3%	54.0	9%	5%
Belle georgia[2]	19.0	0	30.0	0	39.0	2%	47.5	0	
Hale[1+]	25.0	0	42.0	0	52.0	3%	77.0	7%	
Hale[1*]	22.0	0	43.5	1%	49.0	1%	78.5	3%	
Hale[2]	26.5	1%	40.5	0	53.5	2%	85.5	3%	
Early elberta[1]	18.0	1%	35.0	0	43.5	3%	63.5	4%	
Early elberta[2]	17.5	1%	29.0	0	40.0	0	54.0	2%	
Late elberta[1]	15.5	3%	41.5	1%	35.5	2%	50.0	1%	
Krummel[1]	14.0	1%	20.5	4%	46.5	4%	33.0	5%	25.5%



Legend.

Weight in grams.
1= old trees
2= young trees
+= unpailed trees
*= pailed trees

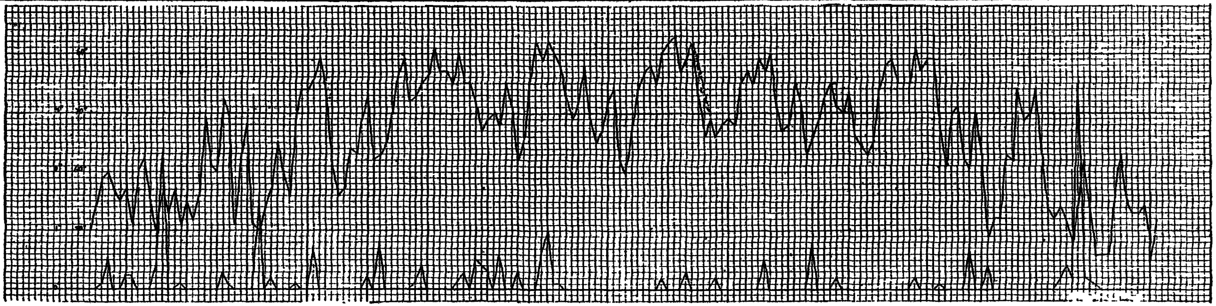
TABLE 5. FRUIT GROWTH, RICE ORCHARD, ADAMS CO., PA., 1929

Variety	June 1			June 10			June 18			June 27			July 10			July 30		
	Lgth.	Diam.	Wt.	Lgth.	Diam.	Wt.	Lgth.	Diam.	Wt.	Lght.	Diam.	Wt.	Lght.	Diam.	Wt.	Lgth.	Diam.	Wt.
Hiley[1]	3.5	2.7	10.5	3.9	2.9	14.5	4.1	3.4	23.0	4.5	3.8	32.0	4.8	4.2	41.0	5.8	5.0	68.5
Hiley[2]	3.6	2.8	11.5	4.0	3.2	17.0	4.0	3.4	21.0	4.9	3.9	34.0	4.5	4.0	34.0	5.1	5.0	54.0
Belle Georgia[2]	3.7	2.7	12.0	4.0	3.3	19.0	4.2	3.6	26.0	4.6	3.9	30.0	4.7	4.1	39.0	5.1	4.4	47.5
Hale[1]†	3.7	3.7	17.0	4.2	3.7	25.5	4.8	4.2	39.5	5.1	4.4	42.5	5.0	4.5	52.0	5.6	5.3	77.0
Hale[1]*	3.8	3.1	14.5	4.0	3.5	22.0	4.7	4.1	40.0	4.8	4.5	43.5	4.9	4.7	49.0	5.4	5.4	78.5
Hale[2]	4.0	2.9	14.0	4.6	4.2	26.5	4.8	4.2	39.0	5.0	4.2	40.5	5.0	4.7	53.5	5.8	5.3	85.5
Early Elberta[1]	3.4	2.6	9.5	4.1	3.3	18.0	4.4	3.8	29.0	4.7	4.1	35.0	5.0	4.3	43.5	5.4	4.8	62.5
Early Elberta[2]	3.5	2.6	10.5	3.9	3.2	17.5	4.4	3.6	25.0	4.6	3.6	29.0	4.9	4.2	40.0	5.1	4.4	54.0
Late Elberta[1]	3.7	2.8	13.0	3.5	3.0	15.5	4.7	3.8	31.0	4.9	4.3	41.5	4.4	4.0	31.5	5.3	4.3	50.0
Krummel[1]	2.8	2.4	7.0	4.0	2.9	14.0	3.8	3.4	21.0	3.9	3.4	20.5	5.0	4.3	46.5	4.4	3.7	33.0

Length and diameter of fruit measured in Cm, weight of fruit in Grams. [1] = old trees. [2] = young trees. † = unpailed trees. * = pailed trees.

TABLE 6, BAIT COLLECTIONS, 1929

	APRIL		MAY				JUNE				JULY					AUGUST				SEPTEMBER				OCT.			
Variety	23	29	7	14	23	29	4	11	18	25	2	9	16	23	30	6	13	20	27	3	10	17	24	1	8	16	Totals
Hiley[1]	0	15	106	17	14	9	6	3	5	8	22	19	13	7	60	101	50	16	3	8	18	21	0	1	0	0	515
Hiley[2]	1	13	29	2	4	4	2	0	1	10	14	6	1	2	216	112	36	41	8	84	183	5	8	8	0	0	786
Belle Georgia[1]	0	19	17	2	11	5	1	0	0	4	11	11	3	5	203	206	111	12	2	2	93	57	6	8	0	0	788
Hale[1+]	0	170	423	60	12	2	13	1	3	8	14	6	3	2	85	191	36	28	16	52	61	284	34	34	2	2	1460
Hale[1#]	0	98	256	33	13	7	10	2	14	14	108	45	6	2	15	21	37	6	5	3	34	84	1	0	1	0	803
Hale[2]	0	4	36	5	9	4	2	1	2	10	20	8	1	1	102	119	44	8	8	4	33	69	12	9	0	0	508
E.Elberta[1]	0	45	113	19	17	26	13	1	0	19	11	12	6	0	97	93	48	53	31	81	92	26	2	3	0	1	810
E.Elberta[2]	0.	31	27	2	7	1	4	1	1	14	8	0	1	1	104	59	45	11	9	3	65	18	0	1	1	0	412
L.Elberta[1]	1	82	516	59	26	5	11	10	3	37	45	25	0	3	61	149	45	14	6	4	103	379	22	2	0	1	1607
Krummel[2]	0	59	88	34	11	1	4	1	1	15	27	26	9	0	71	258	47	11	8	6	66	59	2	1	0	1	795.



LEGEND

Mean daily temperatures in Farenheit
Daily precipitation in 10th of inches.
1 = Old trees
2 = Young trees
+ = Unpailed trees
# = Pailed trees

OTHER METHODS OF DETERMINING INFESTATION. Other methods of determining infestation were tried, namely, dusting trees with a 4 per cent nicotine dust, to bring down the moths; banding trees during the summer and winter, to determine larval and pupal population; weekly counts of eggs per leaf on a given number of leaves, to determine the activities of the moths; and similar counts of cocoons upon the peaches during the summer broods. These methods were tried only on a small scale.

CONCLUSIONS. The data scarcely permits us to draw definite conclusions. However, the influence of certain factors is evident.

There is no doubt that succulent, thrifty twigs are attractive to the larvae during the early part of the season. As the twigs harden and the fruit ripens there is a migration to the fruit, and twig infestation naturally becomes less prominent. On certain occasions larvae were found to enter small green fruit during the first brood, in preference to twigs, because the twigs were not making normal growth. On the other hand, very rapid twig growth may force the larvae from the twigs or even kill them.

The increase in number of moths due to new broods during the summer is evident when studying twig infestation, fruit infestation or making collections from bait traps. The duration of each brood can be determined almost as readily by these studies as by rearing methods.

During preceding years, considerable fluctuation has been noted in the percentages of oriental fruit moth injury. In 1925, there was 145 per cent injury on quince; in 1926, 18 to 25 per cent injury on Krummel; in 1927, 80 to 83 per cent injury on Krummel; in 1928, 13 to 18 per cent injury on Krummel; and in 1929, 25½ per cent injury on Krummel. It would be difficult to say what factors cause these fluctuations. It is pretty well known in Adams County, Pa., that the parasitism has been almost a negligible factor. Seasonal conditions no doubt account for most of these yearly differences, which influence not only the initial infestation and broods but also the set of fruit and the growth of twigs and fruit and these in turn have a bearing upon infestation.

BIOLOGICAL NOTES ON APHIDS AFFECTING APPLES WITH SPECIAL REFERENCE TO VITALITY OF EGGS (APHIDIDAE, HOMOPTERA)

By D. L. Moody and H. B. Mills

ABSTRACT

The studies in Iowa show that aphid eggs are quite sensitive to humidity changes in the fall.

Although there has been much work done on aphids affecting apples in other parts of the country, to the knowledge of the writers there has been no work done in Iowa. Therefore some biological notes from this part of the country should be of value. The following notes were taken during the falls of 1928 and 1929.

On October 29, 1925, a cold wave struck the middle-west, bringing zero and sub-zero weather which greatly diminished the numbers of all insects and it has been only the last two seasons that collectors could function with any degree of success. No aphids could be found in the college orchards at Ames, Iowa, during 1926. Extensive searches in the spring of 1927 revealed only one shrivelled egg and no plant lice were seen at all. In the spring of 1928 only a few were found.

Aphis pomi and *Anuraphis roseus* have been abundant in the falls of 1928 and 1929, especially the latter.

Aphis pomi De Geer. The first observations in 1928 were made in the college orchard on October 5. Both males and females of the oviparous generation were found clustered on the tips of the new growth of young trees. The feeding on the under side of the leaves had considerably distorted them and there was much discoloration from honey-dew. One tree out of every 25 was infested in one orchard of young trees. The females were greatly in preponderance and were feeding quietly but for an occasional ovipository sally down the petiole to the stem. The males were moving about mating promiscuously with the females.

Several light frosts occurred during the last of October and the month of November. Immediately after the frosts the aphids were very sluggish but as the day warmed up their vitality was regained and they were apparently uninjured. A severe drop to 4 degrees F. on December 1 and —6 degrees F. on the 6th killed all of the aphids. On December 9th no live ones were to be found.

On October 12, 1929, *A. pomi* was abundant in the orchards. November 5 they were very abundant and eggs were very numerous. On the 15th of the same month they were still abundant and active in spite of rather severe frosts. A period of zero weather beginning November 24, killed all of the aphids.

Anuraphis roseus Baker. The first fall migrants in 1928 were seen in the orchards on October 25. Many of the winged forms were noticed on the undersides of the leaves. The green apple aphis, *A. pomi*, confined itself to the succulent new growth of the tips but *Anuraphis roseus* was found scattered rather evenly over the tree. As might be expected, the eggs of *A. pomi* are concentrated in great numbers at the tips of the twigs while the eggs of *A. roseus* are found more generally distributed. The eggs of *A. roseus* were first seen October 26. Out of thirty trees examined only three were found apparently free from this species. Several colonies were found breeding on pear (*Pyrus communis* L.) and hawthorn trees (*Crataegus* sp.). *A. roseus* continued in numbers through several frosts and light snow storms to the zero weather of the first six days of December when they all disappeared.

In 1929 this species was first seen migrating back to apple trees on October 12. The flight increased up to the 27th when it was very abundant. On this date some population studies were made on trees in a three year old orchard at Le Grand, Iowa. Although pear blight had killed the trees back considerably the year before, there was an average of 13,547 rosy apple aphids per tree. The species was abundant at Ames on November 5, and eggs were quite common. On November 15 they were still abundant and active in spite of several frosts. The zero weather of November 24 killed them.

The eggs of these species, when first laid, are a bright grass green with sometimes a light yellowish tinge but their color changes in a few days to a shiny black. Matheson (1919) states that this color change takes place in from nine days to two weeks after oviposition under outdoor conditions. Experiments conducted on this point seemed to indicate a somewhat shorter period for color change in this latitude. Oviparous females were put on uninfested apple twigs and were allowed to remain for 24 hours. At this time they were removed, the eggs counted, and the twigs placed out of doors near the laboratory. The average time required for a complete color change was six days, there being a variation of from two to nine days. Two per cent of the eggs did not change to black but turned a dark brown. Other twigs left in the laboratory showed a color change in the eggs in an average of three days. Peterson (1919) says that some *A. avenae* eggs do not change color but retain their greenish tinge throughout the winter, but these, he thinks, are abnormal.

It has been noted by several workers that the number of eggs hatching in the spring is greatly lower than the number laid in the fall. Gillette and Taylor (1908) state that in Colorado but one per cent of the eggs of *A. pomi* hatched. Peterson (1919) observed that from thirty to fifty

er cent of the eggs of *A. avenae* hatched and in a mixture of the eggs of *A. pomi* and *A. roseus* the hatch was near twenty-five per cent. Matheson (1919) gives the following reasons for this low percentage: (1) Climatological factors, including sudden temperature changes and the effect of cold rains near or at hatching time, (2) Predaceous insects and birds, and (3) Non-fertilization of the eggs.

It seems very possible to the writers that another factor may in part account for the high egg mortality. The eggs are quite sensitive to humidity changes in the fall, especially before the change in color. On December 9, 1928, after all of the adults had been killed, a check was made on 1,241 eggs of *A. pomi* and the following data were recorded. Normal black eggs were in preponderance with 73 per cent. There were 5.6 per cent of green and 21.4 per cent of shrivelled eggs. These eggs were kept in the laboratory at a temperature of from 70 degrees F. to 80 degrees F. and an average relative humidity of 27.5 per cent. At the end of six weeks they were examined and practically all had shrivelled.

Another small experiment was carried on to check the results above. One hundred plump black eggs from one twig were divided into two lots of fifty each; one was placed in outdoor conditions and the other was kept in the laboratory. At the end of eleven days the eggs that were kept in the laboratory with a temperature of 70 degrees F. to 80 degrees F. and with a relative humidity of 27.5 per cent had entirely shrivelled while those outside with a temperature averaging just above freezing and an average relative humidity of 77 per cent had shrivelled only 10 per cent.

On November 22, 1929, 350 eggs of *A. pomi* were brought into the laboratory and divided into four lots which were subjected to humidities of 0, 33, 73 and 100 per cents. The temperature in the laboratory was near 80 degrees F. and was the same for all four of the humidity chambers.

Of the eggs at 100 per cent humidity, 10 per cent shrivelled at the end of four days; at 73 per cent humidity 20.4 per cent shrivelled in the same time; at 33 per cent humidity 24.3 per cent shrivelled; and at 0 per cent humidity 51 per cent shrivelled. These results would indicate that there was a direct bearing of humidity on the shrivelling of eggs in the fall. It is admitted that this experiment is somewhat superficial and will need rechecking with larger numbers of eggs and different temperatures.

It would seem, though, that a period of low humidity after oviposition in the fall would cause considerable dessication and might be responsible in a measure for the low hatching percentage of aphid eggs in the spring.

Summary and Conclusions

After the early freeze (in October, 1925) aphids were very scarce in central Iowa until the fall of 1928 when *Aphis pomi* was found in no large numbers and *Anuraphis roseus* fairly abundantly. In the fall of 1929 both species were quite abundant. In 1928 *Anuraphis roseus* was seen returning to the apple the first week in October. Both species continued oviposition until the freeze of December 1. *Anuraphis roseus* was seen migrating to the apple in small numbers on October 12, 1929 and the oviposition of both species was stopped by zero weather

Checks on aphid eggs at Ames, Iowa would indicate that the small hatching percentage of the eggs in the spring might be due to dry atmospheric conditions after oviposition in the fall.

Literature Cited

Baker, A. C., and Turner, W. F. 1916. Morphology and Biology of the Green Apple Aphis. Jour. Agr. Res., Vol. 5, pp. 955–993.

Baker, A. C., and Turner, W. F. 1916. Rosy Apple Aphis. Jour. Agr. Res., Vol. 7. pp. 321–343.

Gillette, C. P., and Taylor, E. P. 1908. A Few Orchard Plant Lice. Colorado Agr. Exp. Sta., Bul. 133.

Matheson, Robert. 1919. A Study of the Plant Lice Injuring the Foliage and Fruit of the Apple. N. Y. Agr. Exp. Sta. (Cornell) Memoir 24, pp. 683–762.

Peterson, Alvah. 1919. Some Studies on the Eggs of Important Apple Plant Lice. N. J. Agr. Exp. Sta., Bul. 332.

DROUGHT-AFFECTED AND INJURED TREES ATTRACTIVE TO BARK BEETLES

By R. A. St. George, *Bureau of Entomology*

Abstract

Hickory and pine trees were reported to be dying from bark beetle attack in several localities and it was found that these trees were affected by a lack of precipitation or were near trees that had been injured by such agencies as wind and lightning and that had thus become attractive to the beetles.

During the past summer additional evidence came to the writer's attention indicating that a special attractiveness of the host tree to bark beetles is created by certain influences directly affecting the tree. These cases appear to be of sufficient interest to be put on record.

Trees Affected by Drought. The city forester of Lansing, Michigan, reported on September 11, 1929, that in Bancroft Park there were between 400 and 500 hickory trees (mostly of the pignut type), of 15 inches diameter breast high and under, that were either dead or in a

dying condition, and that the trees contained broods of the hickory bark beetle (*Scolytus quadrispinosus* Say) in all stages of development.

Surmising that there was a deficiency of rainfall in this region which might have affected the trees and therefore made them attractive to bark beetles, the writer examined the records of the Weather Bureau for that region. It was found that a deficiency had occurred and that it coincided with the period of bark beetle attack.

The first hickory trees were attacked about August 1, and by September, when the foliage on about 70 per cent of them had begun to wilt, the infested trees had increased from a few to nearly 500.

During the period of June, July, and August, when the beetles were most active, there was a deficiency of 1.34 inches, 1.20 inches, and 2.53 inches of rainfall, respectively. This situation bears a close similarity to that which existed in Swannanoa, North Carolina, in 1925, where dying hickories were found to be weakened from the effects of drought and subsequent bark beetle attack. In this instance the lack of moisture checked the growth of the trees. Also, as in Lansing, Michigan, the greatest deficiency came during June, July, and August, when the maximum precipitation normally occurred and when the beetles were most active.

On several occasions pine trees also were found to be in a dying condition and were invariably infested by bark beetles, either Ips or the southern pine beetle (*Dendroctonus frontalis* Zimm.) These attacks are noted below.

Between 450 and 500 white pine trees at Spot Pond, Tewksbury (near Lowell), Massachusetts, were found by the writer, on September 7, to be dead or in a dying condition. These trees averaged approximately 8 inches in diameter, breast high, and 30 feet in height, and were located in a bottomland where the ground is normally moist.

A deficiency of rainfall occurred during June, July, and August of 1.16 inches, 2.90 inches, and 2.50 inches, respectively, and it is believed that because of this the ground on which these trees were located became drier than usual. Their shallow root systems undoubtedly were affected by such changes in moisture, the trees being left in a weakened condition, and consequently they were attacked by bark beetles, principally *Ips calligraphus* Germ. and *I. grandicollis* Eich., which normally do not infest healthy trees.

The remaining trees in the stand surrounding these were apparently unaffected and unattacked. As their root systems would naturally be deeper and more extensive than those in the bottom land, they would be better able to withstand the decrease in available moisture.

During the summer of 1929 the southern pine beetle was unusually aggressive and there were several outbreaks in western North Carolina. Coincident with these outbreaks was a notable deficiency in rainfall.

One large outbreak of the southern pine beetle was located at Hot Springs, N. C. It occurred during September on a section of the French Broad Division of the Pisgah National Forest. In this instance 2,716 trees, mostly pitch pines, were found to be affected. The attack covered some 30 acres of land. Precipitation records for this general region revealed a deficiency of 0.46 inch for July and 2.82 inches for August. A tall, dominant tree had been struck by lightning in the latter part of July and it is believed that this had helped to attract beetles to the area, as about 100 pines were infested around this one soon after it had been injured. The increasing deficiency in rainfall during July and August quite probably affected the remaining trees, making the rapid spread of the beetles possible, because the brood which emerged from the group around the lightning-struck tree had attacked the trees on about 30 acres by October. Several other spot outbreaks of this beetle were found in this same general region.

Another infestation was reported from Richmond, Virginia, during the late summer months. A number of pine trees were said to be dead or in a dying condition in that vicinity. Here also a marked deficiency in rainfall was recorded. During July it amounted to 2.57 inches and in August to 2.01 inches.

No reports of bark beetle outbreaks were received from localities where such a deficiency did not occur.

WIND-THROWN AND LIGHTNING-STRUCK TREES PROVE ATTRACTIVE. In addition to these general outbreaks of the southern pine beetle, several instances were noted where wind-thrown and lightning-struck trees had served as a definite attraction for the beetles in drought-affected areas.

During September an outbreak of the southern pine beetle, which affected some 80 or 90 trees, was found centered about a recent blow-down, about 10 miles from Hot Springs, North Carolina, west of Mooneyham Branch in Tennessee. The storm-felled trees were infested as well as those surrounding them. Another similar instance was noted near Winston-Salem, North Carolina, where about 50 trees were affected. In the general region of both of these places there was a marked deficiency in rainfall. On September 28 a group attack of this beetle was located near Bent Creek, North Carolina. In this instance the beetles were attracted to 15 shortleaf pines on August 25 as the result of the skinning of one of the trees by a large, overmature scarlet oak which fell against it during a storm a few days previous to this date. The injured

tree was 10 inches in diameter breast high and about 50 feet in height. Some of the limbs were broken off and a portion of the bark bruised as the result of the oak tree falling against it. This injury undoubtedly resulted in the attraction of bark beetles to the surrounding 14 trees which ranged from 3 inches to 10 inches in diameter breast high and from 25 to 50 feet in height. When the infestation was discovered the brood had already matured and was ready to emerge in most of the trees; blue stain had extended to the heartwood and the foliage was almost brown.

A number of cases were noted near Asheville, North Carolina, which indicated an attraction of the southern pine beetle to lightning-struck trees. On August 1 the writer's attention was attracted to one of these trees by the fading foliage. It was a shortleaf pine 10 inches in diameter breast high and 35 feet in height. The lightning had not only split open the bark the entire length of the stem of this tree but also had exposed one of the main roots. At the time of discovery a maturing brood was found in it. Near this tree were two large and five small infested pines which had not been struck by lightning. The large trees were 12 inches in diameter breast high and 35 feet in height, and 9 inches in diameter breast high and 25 feet in height, respectively. All seven trees had been attacked as a result of the attraction of beetles toward the lightning-struck pine.

Two other lightning-struck trees were found infested by the southern pine beetle in this same general region, but they did not attract enough beetles to kill any of the trees surrounding them. Several additional records were obtained en route from Asheville, North Carolina, to Washington, D. C., during early October. Isolated infested trees or small spot infestations could be seen at intervals along the highway from Morgantown to Winston-Salem, North Carolina, in which general region there was a deficiency in rainfall. In 21 cases examined it was found that lightning had struck a tree, which in turn was attacked by the southern pine beetle. Usually from 2 to 10 surrounding pines were also attacked and killed as the result of this attraction.

THE THRIPS FACTOR IN ONION STERILITY[1]

By HELEN MONOSMITH PEARSON

ABSTRACT

Observations show that *Thrips tabaci* may be an important factor in producing onion sterility, since the insects may seriously damage the essential organs of the flowers.

Thrips tabaci is considered a serious pest in the growing of onion bulbs. It thrives on a number of crop plants; and that thrips may cause sterility has probably been noted frequently before. It is probably thrips to which such statements as the following refer: "Partial and entire degeneration of anthers, and sometimes of the entire flower," in sugar beets, "was often observed by the writer in material which harbored in the inflorescence axis or its lateral branches the encased larvae of insects." (Artschwager, 1927). But the extent and seriousness of the harm thrips do the seed industries, particularly the onion seed industry, does not seem to be realized.

SEVERITY OF THE ATTACKS. Most of the observations here recorded were made on inbred Australian Brown onions, a late blooming variety, although thrips-infested plants of several other varieties were also examined. In a badly infested flower head there may be half a dozen or more thrips feeding on every flower. Thrips infestation is much worse in late varieties, and in the later seed heads of early varieties, than in earlier ones. This is probably due to the thrips' shorter life cycles at higher temperatures, which allows them to increase more rapidly, and to the lowered moisture supply. Wardle, Simpson, and MacGill (1927) find that a moist soil, or one frequently wetted and allowed to cake on the surface, does not seem to be favorable to the soil-pupating larvae of *Thrips tabaci*. These authors note that differences in susceptibility of different plants and different parts of plants seem to be due to differences in thickness of the epidermal layer and in rate of growth, a vigorous fast-growing plant being able to keep ahead of the attack. This was strikingly illustrated in a greenhouse experiment with twenty Yellow Danvers Flat onions, a variety of medium growth rate, and three Italian Red onions, a variety which grows perhaps twice as fast and luxuriously as Yellow Danvers Flat. A severe thrips attack killed all of the former, but only somewhat checked the growth of the latter. In the seed plots in the field some plants seemed to be much more severely infested than

[1]This investigation was supported by the Truck Crops Division of the Branch of the College of Agriculture of the University of California at Davis, California.

others of the same variety receiving the same treatment. These usually appeared to be the less vigorous plants, perhaps weakened by disease.

STERILIZING EFFECTS. Wardle, Simpson, and MacGill (1927) have investigated the feeding habits of thrips. They find that thrips feed by gashing the outer wall of the epidermis with the mandible, inserting the mouthparts through the cut, and gashing the inner walls of the epidermis and walls of the subepidermal cells with the longer, protruded maxillary lacineae, then sucking the contents with the aid of a partial vacuum established within the mouth cone closely applied to the epidermis. Death of the affected cells and surrounding cells is probably due to this cutting and sucking, and not to any toxic salivary secretion.

Thrips gain admittance to very young buds of the onion, for they have frequently been sectioned in flower buds with the pollen mother cells still in prophases. Perhaps the thrips force their way between the healthy perianth segments, but more likely between segments partially killed by earlier feeding. Within the young buds the thrips do a great deal of harm to the immature stamens and pistils. Sections show numerous thrips lesions into the anther locule cavities—paths of dead cells extending through all of the wall layers. The suction seems to burst the tapetal cell membranes, for, unlike normal anthers which in prepared slides show no contents but microspores, such anthers are usually filled with a thick tapetal periplasmodium which appears to have been sucked towards the lesion. A thrips attack may be followed by death of all the anther contents and collapse of the anther cavity, or few to many of the microspores may hypertrophy and pack together, giving a parenchyma-like appearance, usually interspersed with masses of material from dead tapetal cells and microspores. A thrips, accustomed to sucking only a few cells at a time, must certainly be happy to tap a whole anther locule! Thrips frequently feed upon the styles and stigmas, probably rendering the latter partially or entirely unreceptive, depending upon the age at which they are attacked and the severity of the attack. Thrips can perhaps harm young ovaries directly, but not the thick-walled older ones. They cannot harm mature anthers because the pollen grains are independent when dry, and also because the endothecium has become very thick. Perhaps the thickened endothecium serves as a protection against thrips even for a short time before the anther fluid has disappeared.

Aside from sucking the essential organs directly, thrips may cause sterility by feeding on the flower pedicels. In badly thrips infested buds, although an anther itself may not be sucked, its tapetal layer may degenerate abnormally while the rest of the anther still looks normal.

Shrunken tapetal cells with dense, homogenous appearing cytoplasm may thus occur in locules with normal prophase pollen mother cells, dyads, tetrads or very young microspores, instead of the usual layer of large, vigorously growing, large-nucleated cells. Just how important these and the corresponding effects on the pistils are in causing sterility is difficult to ascertain, since some badly scarred pedicels may bear apparently normal stamens and pistils. It is safe to assume that extensive feeding on the pedicel of the young bud may cut off its food supply, if not directly, since the conducting elements lie fairly deep, indirectly by killing large sections of the small pedicels. Similarly, feeding on the filaments of immature stamens cuts off the food supplies of the developing anthers. A reliable index of thrips infestation is the number of eggs laid in the flower (they are laid just beneath the epidermis) since the parents must have been feeding near. However, two or three eggs may be laid in a single flower, even in its pedicel, which seems to be an especially favored place, without any obvious sterilizing effects. This is especially true of older buds, since the attack on these probably did not begin until at least the pollen grains were out of danger. Thrips cannot seriously injure the developing ovules after the eggs have been fertilized except by feeding on the flower pedicels.

CONTROL. Nicotine sulphate and whale oil soap is an effective spray for thrips, although scarcely practicable. An insect, *Triphleps tristicolor* White, slightly larger than the thrips, preys upon it. How important *Triphleps* is as a check upon the thrips population is not known. Thrips are held in check by cool, moist weather.

LITERATURE

ARTSCHWAGER, E. 1927. Sporogenesis in the sugar beet with special reference to the problem of incompatibility. Mem. Hort. Soc. N. Y. 3: 295–297.

WARDLE, R. A., SIMPSON, R., and MACGILL, E. 1927. Biology of Thysanoptera with reference to the cotton plant. Ann. Appl. Biol. 14: 482–528.

INJURY TO SUGARCANE BY A SMALL WEEVIL

By J. W. INGRAM and T. E. HOLLOWAY, *Bureau of Entomology, U. S. Department of Agriculture*

ABSTRACT

The newly discovered injury to sugarcane by a small weevil, *Anacentrus* sp., is described. The character of damage is the destruction of the eyes of sugarcane and also killing of the young plants.

As long ago as 1919 the larva of a small weevil was reported by Holloway and Loftin[1] as making small borings in old cane stubble. This had been determined by W. Dwight Pierce as *Limnobaris sp.* Recently, specimens have been determined by L. L. Buchanan as *Anacentrus sp.* Mr. Buchanan writes, "This species is undescribed in all probability, though quite closely related to *planiusculus* Csy." The adult of this cane weevil is dark brown in color and from 3½ to 4 mm. long and 1 mm. wide. The larva is white with an amber-colored head. The pupa is white until just prior to emergence, when it becomes slightly brown.

Holloway and Loftin reported no injury, but it appears that the weevil is becoming injurious, or else climatic or some other influences cause it to become more important at times. In 1925 there was a report from a plantation at Franklin, Louisiana, that this weevil was doing damage and it was said that the insect bored into the woody part of the young plants just at the point where they leave the planted seed cane, killing them. The stand was therefore reduced. In many cases, however, the cane sprouted again and the new sprouts were not killed. The present writers visited this plantation on July 8, but at that time the damage had ceased. Out of 1,800 acres, the planter stated that only about 10 acres were infested and that there was a loss of only about two acres. The weevil, therefore, was not regarded as seriously injurious.

In examinations of sugarcane fields made during the past winter and spring, it was found that the same weevil was doing damage to cane stubble in all fields examined and in some fields had been an important factor in reducing the stand of stubble cane. The weevil larvae made tunnels in the cane stubble resembling those of the sugarcane borer, except for their much smaller size. In some cases the stubble was riddled with tunnels and all eyes killed either directly by the weevil larvae or by the entrance of disease organisms into the tunnels. The weevil tunnels were found most often at the nodes and near the outer surface of the stalk. Often eyes were found which the weevil larva had

[1]Insects Attacking Sugar Cane in the United States, by T. E. Holloway and U. C. Loftin. Journal of Economic Entomology, 12, p. 448–450, 1919.

hollowed out, thus forming a chamber in which it pupated. The injury was as a rule heavier in second-year than in first-year stubble. Injury was rarely found in plant cane, and when this occurred larvae were found boring in the young plant near the place where it joined the mother seed cane.

The adult weevils appeared to be most numerous in soil surrounding the cane stubble, in August and September. Evidently eggs were laid in the stubble about this time. The first pupa was found in stubble on January 20. The first newly emerged adult weevil was found on February 10. Larvae were found in cane stubble all during the winter and as late as June 11. In examinations made of cane in first-year stubble fields in April, it was found that about 54 per cent of the eyes were dead. Of this percentage 13 per cent had been killed directly by the larvae. Judging from a small number of stubble examined in adjoining plots this year, weevil injury has been heavier in the varieties known as D. 74 and Louisiana Purple than in P. O. J. 213.

No control measures are known thus far, but in case the damage should continue, experiments in control will be conducted.

INSECT PESTS OF UPHOLSTERED FURNITURE

By E. A. BACK and R. T. COTTON, *Bureau of Entomology, U. S. Department of Agriculture*

ABSTRACT

Insects as pests of upholstered furniture have become much more destructive during the past few years. This seems to be the result of the increased sales of upholstered furniture covered with woolen fabrics and filled with vegetable or animal materials susceptible to insect attack. Psocids and the tobacco beetle, while annoying to the owner, seldom appear to affect seriously the appearance or usefulness of furniture. Carpet beetles are minor pests, except in the case of the furniture carpet beetle. This insect is capable of rendering furniture both unsightly and unusable by devouring hair and feather upholsterings and by feeding on the wool in covers. Clothes moths, more especially the webbing clothes moth, are the most destructive of all pests since they persistently attack woolen covers, are so widely distributed, and spread so easily.

Ten years ago the inquiries received by the Federal Bureau of Entomology relating to insects affecting upholstered furniture were exceedingly few. But today, and for several years past, a considerable volume of correspondence on this subject has developed from all parts of the country, indicating the widespread injury and interest these pests are causing. The losses due to insect attack upon furniture are still further evidenced by the complaints received, not only from the house-

wife but from the furniture manufacturer, the retailer and the warehouseman, and by the ever-increasing volume of business transacted by insect exterminators, dry cleaners, laundrymen, and household-goods warehousemen, who, in ever more extensive advertising campaigns, offer to the public fumigation and moth-proofing services.

It is no longer safe for furniture warehousemen to store upholstered furniture without safeguarding it from insect ravages during the storage period. All up-to-date storage houses are now "moth-conscious" and have installed fumigating vaults or special storage space in which furniture can be rid of insect infestations. Of course it has been the vogue for beautiful woolen covers and luxurious furniture that has given insects an increased field for activity. The average American home today contains a greater abundance of material upon which this group of pests can develop than ever before. Only a brief mention of the principal pests is made here.

Clothes Moths

The Webbing Clothes Moth (*Tineola bisselliella* H.). The most destructive of furniture pests is the webbing clothes moth. Its attack upon mohair-covered upholstered furniture is costing the householder in this country an estimated half million dollars annually. The larvae feed not only on the outer surface between the rows of pile but also on the under side. In either case, the aesthetic value of the furniture is ruined. While the surface feeding can be prevented by constant watchfulness and by brushing the pile, the larvae beneath the covers may become very abundant before their presence is even suspected by a careful housewife. These hidden larvae are the ones which sever the pile threads where they pass beneath the foundation warp, thus causing the development of bare spots in mohair through the falling out of the cut threads when the covers are cleaned. The writers believe that about 90 per cent of the well-defined bare spots in mohair-covered furniture are the result of opportunities given the moth larvae, through faulty construction, to reach the underside of the covers.

Case-making Clothes Moth (*Tinea pellionella* L). While the case-making clothes moth is not so commonly reported as injuring upholstered furniture, it can be very destructive. It is most conspicuous as a pest of feather filled upholstery. Feather and down cushions are sometimes completely reduced to a mass of frass, dead insects and their cases, and feather quills.

Carpet Beetles

The Furniture Carpet Beetle (*Anthrenus vorax* Casey). The furniture carpet beetle has become a most serious and destructive pest of furniture upholstered in hair and feathers. First discovered some years ago in Washington at the White House in chairs from a European country, the insect is now widespread throughout the older residential sections of the city. It is found in furniture often in unbelievable numbers and when so abundant not only consumes all susceptible stuffings but turns its attention to the covers, the larvae eating holes in the warp and through these passing to the outside where they begin eating off the pile in every widening patches. The covers of badly infested pieces sag, becoming pileless and unsightly. The leather-covered and hair-filled furniture of the Capitol Building and of leading clubs and private houses of Washington have yielded excellent examples of advanced cases of infestation. Often the householder's attention is first directed to the species by the large number of larvae and adults found crawling about the room. Furniture, held in storage in Washington for some months was found, after shipment to Chicago in 1929, to be badly infested. Undoubtedly the furniture carpet beetle will become in time a widely distributed pest in America.

Black Carpet Beetle (*Attagenus piceus* Oliv.) and the Common Carpet Beetle (*Anthrenus scrophulariae* L.). These insects are found frequently in very small numbers in furniture, especially the black carpet beetle. Neither species seems destructive enough to warrant much attention. In one instance a leather-covered chair was found so badly infested that many small holes were eaten in the cover by escaping specimens.

Tow Bugs

A few years ago all insects affecting upholstered furniture were spoken of by the furniture trade as "tow-bugs." One was at a loss to know what insect was involved in litigation when it was discussed as a "tow-bug." Today, clothes moths and carpet beetles are no longer "tow-bugs," this appelation being reserved more strictly for insects that feed upon vegetable upholstering materials. Such materials consist mainly of flax tow, palm fiber, sea moss and Spanish moss. The most common "tow-bugs" are the common tobacco beetle, the psocids or book-lice and, more rarely, the drugstore beetle (*Sitodrepa panicea* L.).

The Tobacco Beetle (*Lasioderma serricorne* Fab.). This insect, so well known to the entomologist, plays a very important role as a furniture pest, particularly of furniture upholstered in flax tow or straw.

All infestations observed by the writers have been in furniture in which flax tow was used as part of the stuffing. Furniture in which other vegetable materials were used to the exclusion of flax tow have not become troubled with the tobacco beetle. Flax tow has the advantage of being much cheaper than other vegetable materials commonly used in furniture construction, and this fact will result in its continued use by many firms.

The inquiries and specimens received through the correspondence of the Federal Bureau of Entomology make it impossible for the writers to indicate any one region as more subject than others to tobacco beetle attack in furniture. Some firms, however, avoid the use of flax tow in furniture to be sold in certain areas where complaints have indicated that conditions are peculiarly favorable to tobacco beetle increase. Thus it is understood that certain regions of the Ohio and Mississippi Valleys have been black-listed because of the numerous tobacco beetle infestations reported by patrons of furniture houses.

An examination of the flax-tow upholstering of a chair brought out the fact that not a single small handful of the straw was free of infestation, and larvae in all stages were observed. The larvae feed directly upon the straw. Only rarely are the covers of the furniture eaten and then only for the purpose of making exit holes. It would seem that the larvae and adults which often swarm from furniture in great numbers are able to leave the furniture through openings about seams and about the springs. When unable to do this, they are capable of eating holes in covers.

PSOCIDS. Psocids seem to do no harm to furniture but they do often develop to tremendous numbers in the vegetable upholstering material and, leaving the interior, crawl over the covers and woodwork and greatly annoy the owner. No furniture has been reported visibly damaged by their development, but the presence of these insects, so common everywhere, is sufficient cause for the many free fumigations given by the furniture dealer for the benefit of their customers.

LITERATURE

BACK, E. A. and COTTON, R. T.

1. Insect Control in Upholstered Furniture, The Furniture Warehouseman, Vol. VI., No. 5, May, 1926; 11 Figs.
2. Moth-Proofing Solutions. Furniture Warehouseman, Vol. 8, No. 10, Oct., 1927.
3. Tobacco Beetle as a Pest of Furniture. Furniture Manufacturer for Dec., 1927; 12 figs.
4. How Cotton Batting Prevents Moth Damage. Furniture Manufacturer for Jan., 1928; 21 figs.

5. Protect Upholstered Furniture from Moths. The Bulletin, National Retail Dry Goods Association, Vol. 10, No. 2, Feb., 1928; 5 figs.
6. Moth-Proof Your Upholstery. Furniture Manufacturer for April, 1928; 12 figs.
7. Getting Rid of Insects. Furniture Manufacturer for May, 1928; 9 figs.
8. One Moth May Live for Four Years. Monthly Review of the National Retail Furniture Association; Vol. 3, No. 8; Aug., 1928; pp. 2–4; 8 figs.
9. Tow Bugs and Who's to Blame for Damage. Monthly Review of the National Retail Furniture Association; Vol. 3, No. 4; Apr., 1929, pp. 3–10 and 16; 9 figs.
10. Moth-Proofing Solutions. Monthly Review of the National Retail Furniture Association, Vol. 3, No. 6, June, 1929; 5 figs.
11. The Control of Moths in Upholstered Furniture. Farmers' Bulletin, Bureau of Entomology, U. S. Dept. Agric. (In press, July, 1930).

RECENT DEVELOPMENTS IN *TRICHOGRAMMA* PRODUCTION

By Stanley E. Flanders, *Citrus Experiment Station, Riverside, Calif.*

Abstract

This is an account of the commercial production of *Trichogramma* during the season of 1930. Improved types of equipment are described. Parasitism by *Trichogramma* was obtained in complete darkness as well as in daylight.

In Orange County, California, during the spring and summer of 1930 there was established by private interests the first plant for the commercial production of *Trichogramma*. During the first months of operation the writer acted as technical advisor.

The production units were housed in one of the buildings of the County Insectary originally built for the mass production of the coccinellid, *Cryptolaemus montrouzieri*. That the building was available was due to the effectiveness of the newly introduced parasites of the citrophilus mealybug which made possible a decided reduction in beetle propagation.

The climate of the section in which the insectary is located is very favorable to the economical production of *Sitotroga cerealella*, the laboratory host of *Trichogramma*. It is generally temperate and humid throughout the year, so neither artificial heat nor artificial humidity are required.

Three rooms were fitted up for moth production, one for egg deposition and one for parasite propagation. Each moth room contained a set of twenty wooden trays filled with 8500 pounds of common white corn. A single tray measures inside 9 feet in length, 30 inches in width and 5 inches in depth. The total cost of one unit set up, exclusive of the corn, was about $200.00. Each unit consisted of two parallel stacks of

trays, 26 inches apart. The outer sides of the bottom trays rested on the floor, the inner sides on two parallel 2-inch planks each 12 inches wide and 9 feet long, set up edgewise. These planks were held in position by two shorter pieces 26 inches long, one at each end. The inner side of each tray was 1/8 inch lower than the other three sides, in order to permit emergence of the moths from the trays. The outer side of each tray was 1/4 inch above the bottom of the tray and the opening thus formed was faced on the inner side with a 30 mesh screen. Air can, therefore, be forced through the crevice at the upper side, down through the grain and out of the crevice on the lower side.

As each tray is filled, all the corn above the level of the sides is scraped off so that the weight of the bin above is supported only by the sides and crosspieces of the bin below.

A cover is placed on the top tray of each stack. The covers are wide enough so that they come together over the space between the stacks forming a solid roof. To complete the enclosure long cloth is tacked and pasted over the ends. A cloth door (2 feet x 3 feet) is constructed at one end. In the other end an electric fan is placed in a circular hole cut in the cloth. This fan blows in cool humid air continuously.

A piece of 1 inch pipe 5 feet long placed on one side of the enclosure about 4 inches from the floor extends from mid-way of the enclosure through one of the end planks. A standard vacuum collecting hose is fastened to the inner end, the other end outside of the enclosure serves as a connection to a portable moth trap. This trap is made up of the following parts:

1. A cylindrical cage (8 inches x 20 inches) of 20 mesh brass screen with a removable cap on one end.

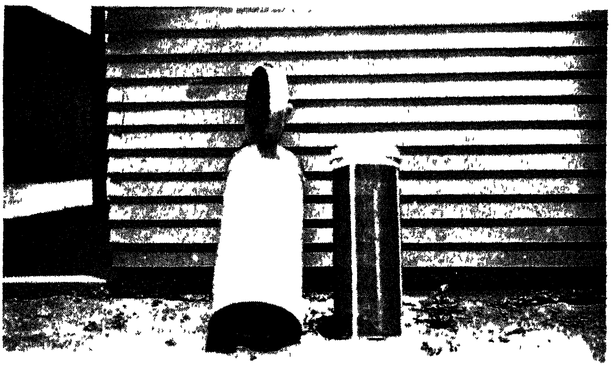
2. A cylindrical housing for the cage made of sheet iron. This housing is 10 inches in diameter and 24 inches in length. In the bottom is a 1 1/4 inch opening which forms the inner end of a pipe 2 inches long. The bottom is inset 3 inches so that the housing can be set upright when assembling the trap.

3. A coil of spring wire 3 inches in height and 4 inches in width.

4. A cover to the housing with a 1 1/4 inch pipe through its center and projecting 2 inches on either side. The inner side is faced with a soft rubber pad 1/2 inch thick.

In assembling the trap, the spring coil is placed on the bottom of the housing. The cage, with cover removed, is set on this spring and then the housing cover is placed on top. The cage is then forced down until the cover can be locked in position.

Trap in position for operation



Moth cage and housing

The spring presses the mouth of the cage against the rubber pad so that the moths cannot escape. The cage is in a horizontal position when in use. An electric motor and suction fan are attached to the pipe at the bottom end of the cage by a flexible tubing, a similar piece of tubing also connects the pipe on the housing cap to the outer end of the pipe leading into the moth enclosure.

When a sufficient number of moths are collected in the trap, it is set up on end, the cover unfastened and the cage vibrated on its spring to shake down the moths so that the cage cover can be placed on without losing any.

The cage containing the moths is then placed in another cylindrical housing for the deposition of eggs. This housing is 10 inches in diameter, 4 feet in length and open at each end. Two strips of sheet iron 1 inch wide and placed 3 inches apart extend the length of the tube These serve to hold the cage in the center of the cylinder when in a horizontal position. An electric fan is placed at one end and a baffle board and a trough at the other end to deflect the air current and concentrate the eggs deposited in the air current.

The eggs are then cleaned and placed on egg cards. In preparation for this, shellac is stamped on to the cards (4 inches x 8 inches) in small squares. A piece of birch wood grooved across and lengthwise to form a series of raised blocks is used as a stamp. The surface of this is coated with shellac and then pressed on to the cards. Eggs poured on to the card adhere on uniform squares facilitating the counting of the eggs and cutting of the card into small units for liberation

An infestation of *Sitotroga* was built up in the corn for a month prior to placing it in the bins. During the period of infestation the corn is kept at a temperature of 80°F. After being placed in the bins no artificial temperature is required, in fact it was necessary to reduce the heat of infestation by constantly circulating cool humid air through the corn. For mass production the optimum temperature is about 85°F.

During April and May, *Plodia interpunctella* became so numerous as to interfere somewhat with parasite production. It was practically impossible to segregate the *Sitotroga* adults from *Plodia* adults before placing them in the egg deposition cages, or their eggs before placing them on the egg cards. The larvae from unparasitized *Plodia* eggs fed on the parasitized eggs and spun a dense webbing over the entire mass. This trouble was entirely eliminated by the introduction of *Habrobracon juglandis* into the moth rooms. This parasite increased rapidly until *Plodia* larvae were rarely seen on the egg cards. In this connection it is interesting to note the peculiar oviposition habit of *Plodia*. The female

appears to prefer to deposit its eggs on single strands of silk stretched across crevices and between kernels of corn. They then have the appearance of beads on a string. The *Ephestia cautella* has a similar habit.

The first unit was filled with corn May 4. Ten days later the egg production amounted to 100,000 daily. On May 30 it reached 200,000. During June, July and August the production from this set averaged over 500,000 eggs daily. The second unit reached full production June 23. The third unit began producing moths abundantly the first of July. About the middle of August, however, a parasite of the larvae of *Sitotroga* was noticed in considerable numbers in this set. It increased so rapidly that by the end of the month production had declined to practically nothing. All three units were finally invaded and production ceased.

This parasite was identified by Gahan as *Habrocytus cerealellae*. It also oviposits in the cocoons of the potato tuber moth larvae. The incubation period of the egg at 80° F. is less than 24 hours. The invasion of this parasite emphasizes the fact that insect proof insectaries are necessary for work of this type.

The type of cage used for obtaining parasitism is a wooden box with one side of glass so constructed that when in use no light can enter or parasites escape. The box measures inside 4 inches in height, 8 inches in width and 16 inches in length. Two of the sides (4 inches x 16 inches) are fastened on with clamps. One serves as a door and the other to cut off light entering through the glass wall opposite. The inner surface of the top and bottom are grooved ⅝ inch apart, each groove wide and deep enough to hold two egg cards back to back. When loaded to full capacity it holds over 2,000,000 eggs.

In loading the box it is placed so that the glass side is toward the source of strongest light, the sides are then removed and a strong current of air is directed across the opening to prevent the escape of the parasites. The used stock cards and newly parasitized cards are then removed and replaced with a new supply.

When large quantities of eggs are to be parasitized in such a container, it is preferable to have the parasites emerge from the stock cards as soon as they are placed in position. Wishart first made use of the retarding effect of darkness and cooler temperatures on the emerging parasites in order to obtain complete emergence within a short period. Light is admitted to the box until practically all the parasites have emerged.

Light entering a container from one direction apparently interferes to some extent with oviposition of certain strains.

When the temperature of the parasite room is maintained at about 80° F., the parasites commence to emerge seven or eight days after oviposition, depending on the strain used. The emergence can be delayed nine days by placing the parasites in a constant temperature of 53°F. one day before they are due to emerge at 80° F.

For several weeks during July and August, the number of parasites produced daily at the Orange County laboratory amounted to well over 1,000,000. The total number shipped out for liberation in the field up to the first of September was over 20,000,000. It is estimated from the number of eggs in storage and parasites on hand that 10,000,000 will be available for shipment during the first two weeks of September.

For experimental work the writer devised a simple type of unit, which consists of a cone 8 feet in diameter made of 18 gauge galvanized sheet iron. It is made in two sections and is fastened together with bolts and wing-nuts. At the apex is an aperture 6 inches in diameter. This forms an opening for filling the cone with corn and for the emergence of the moths.

The sides of the cone form an angle of 22.5° with the horizontal. At this slope there is no flow of corn and the entire cone can be raised about 1/8 inch. There is then sufficient space over the entire surface of the mass of corn to allow the newly emerged moths to crawl upward toward the exit. The lower edge of the cone can be banked with sand to prevent any moths from escaping.

In order to trap the moths, a cylindrical cage (6 inches x 12 inches) made of 20 mesh brass screen is placed over the aperture at the apex. The cover of the cage is made of tin and is an interiorly directed cone having sides sloping at the same angle as those of the larger cone. At the apex of the cover is a 1/4 inch aperture through which the moths enter the cage. A tin disk 2 inches in diameter is fastened to the apex so that the aperture is at its center. This disk decreases the chances of the moths reentering the cone. When the trap is inverted and placed in position its cover is just large enough to fit over the 6 inch aperture of the large cone containing the corn. A ring of clay or putty at the edge of this aperture can be used as a base on which to place the trap so that moths cannot escape.

This unit is rendered useless for *Sitotroga* production if *Plodia* larvae are present, since they spin a dense webbing over the aperture of the cone.

References

Ashmead, W. H. A new Catolaccus on *Sitotroga cerealella* Oliv. Psyche 9: 345. 1902.

Wishart, Geo., Large scale production of the egg parasite *Trichogramma minutum.* Riley. The Canadian Entomologist 56: 73–76. 1929.

OBSERVATIONS ON THE "YELLOWS" DISEASE OF BEANS AND RELATED PLANTS IN HAITI

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Abstract

A disease of beans resembling a mosaic but named a "yellows" disease of serious importance in the low lands was found to be transmitted by a new species of *Empoasca* leaf hopper. No other insects transmitted the disease during these studies. There was considerable varietal difference in susceptibility and loss observed, the Lima bean group of which Jackson Wonder was particularly studied being able to mature a fair crop in spite of the disease. The paper records also historical observations, experiments to determine the relation of various insects to the disease, inoculation tests, possible inheritance through the seed and control experiments with Bordeaux mixture and nicotine sulphate, both failing to control either the leaf hoppers or the disease.

For several years the Department of Plant Pathology has observed the presence of a very severe bean disease and has recorded it as Bean Mosiac.[1] However, certain peculiarities were observed which aroused doubt as to the identity of this malady. For example, in the summer of 1926, an outbreak at Thor, near Port-au-Prince, on cow peas following a heavy infestation of leaf hoppers was observed, the progress of which appeared to be arrested somewhat by spraying with Bordeaux mixture, altho no control plots were left unsprayed. Similar outbreaks during the same season occurred in the horticultural plots on cow peas which had been severely infested with leaf hoppers.

Numerous observations at Damien, Haiti, appeared to indicate a relationship of the disease to leaf hoppers. Furthermore, repeated search had not revealed the presence of any aphids, some species of which are considered to be carriers of mosaic. The known relation of certain species of leaf hoppers to alfalfa yellows and aster yellows pointed to the possibility of a similar condition with beans. Wolcott (1923) quoted from four authors who mentioned similar if not identical injury to beans and cow peas by *Empoasca mali* L. B. in Porto-Rico.[2] Consequently, early in 1929, experiments testing the possible relationship of the bean leaf hopper of Haiti to the so-called mosaic disease of beans and related plants were begun.

Economic Considerations. The disease is very general in Haiti, occurring wherever beans are grown. There are, however, some peculiar seasonal and topographical modifications. In the low lands or plains

[1]Annual Report of the Service Technique, 1924–25, p. 90.

[2]Wolcott: Insectae Portoricensis, Jour. Dept. Agr., Porto-Rico, -7, No. 1, p. 269. *E. mali* L. B. equals *E. flavescens* Fabr. according to De Long.

susceptible varieties cannot be grown during the summer months (April to Oct.) whereas in the winter months (Dec. to March) such varieties are ordinarily little damaged by the disease. But in the mountainous regions, at an altitude of 2,500 ft. or more, very susceptible varieties can be grown during the summer season without much or any loss from the disease. For example, the Plant Disease Survey recorded in July, 1924 a large field of "Pois rouge" on the Pineapple plantation at Cap-Haitien completely destroyed by the disease, whereas on the same date this variety was fruiting well with little damage on top of Pilsboro mountain at an altitude of about 3,000 ft. Therefore, it may be said that this disease limits the production of beans in Haiti to a very short season, except for localities of high elevation. Since beans constitute one of the most important native foods, the problem is of fundamental importance. It is probably important also in neighboring islands.

NATURE OF THE DISEASE. In planning and conducting these experiments the authors were unable to find any clear references to this particular disease in the literature available. Beyer (1922) described one or more diseases which he calls "hopperburn,"[3] but the descriptions are not sufficiently clear to establish the identity of those diseases with the "yellows" of beans in Haiti, altho it appears probable from the illustrations on page 68 and 99 of his report that this disease was involved. However, his description of hopperburn which follows does not correspond to the symptoms commonly manifested under Haitian conditions.

"The tender surfaces of the leaves and stems are penetrated, and as a result of the loss of juices the plants take on a yellowish appearance. The next injury to appear is called tipburn or hopperburn which starts with a slight yellowing often at the tip of the leaf, and as the injury progresses along the margin of the leaf the color turns to a dark brown and the leaf begins to curl upward at its apex... This trouble is identical with that which Dr. Ball described as occurring on potatoes."

In Haiti, the disease generally takes the appearance of a "typical" mosaic disease, and does not suggest the tipburn or hopperburn of potatoes. However, the symptoms vary so widely with different varieties that a generalized description might be misleading. Discussion therefore will be reserved for remarks under varietal differences. However, the plants of all varieties were appreciably stunted by the disease.

[3]A. H. Beyer, The Bean Leaf Hopper and Hopperburn with Methods of Control, Fla. Agr. Exp. Sta., Bul. 164, 1922.

This was more marked if the disease developed early. Climbing varieties are reduced practically to bunched plants, while if protected in the cages, they exhibited the normal climbing tendencies. The amount of bloom was reduced in all varieties which in turn reduced the yield correspondingly. The name "hopperburn" is not regarded as appropriate for this disease, since there is no burning or drying of foliage, except in the last stages, but a yellowing occurs instead, so the term "yellows" is here used. This designation is in harmony with aster yellows, alfalfa yellows, and other diseases that have been grouped under this appellation.

METHODS EMPLOYED IN THE EXPERIMENT. The purposes of the experiments were to determine any possible relationship of the bean leafhopper of Haiti (determined by Dr. D. M. De Long as a new species of *Empoasca*)[4] and other insects to the disease, the nature of the disease and methods of control. The following experiments were conducted:

a. Series of beans were grown in very fine mesh, insect proof, wire cloth cages (Pl. 32, fig. 1) and compared with the same varieties planted at the same time in the open.
b. Various insects were separately introduced at various stages of the growth of the beans and results noted.
c. The effects of environmental conditions such as partial and complete shade were studied.
d. Possible transmission by means of seed from diseased plants was tested.
e. Varietal differences in susceptibility were studied.
f. Artificial inoculations were made on healthy plants with the juice from diseased plants.
g. Spraying with Bordeaux mixture and Nicotine sulphate as control measures.

DISCUSSION OF RESULTS OBTAINED

a & b. Repeated tests with three varieties, Black Valentine, Jackson Wonder and Kentucky Wonder, the seeds of which had been purchased from the Reuter Seed Co. of New Orleans, failed to develop the disease during 1929 on beans grown in insect proof screened cages (Pl. 32, fig. 1).

Three small cages were placed inside the large screened cage containing disease-free plants approaching the blooming stage. In the first study 77 specimens of the common bean leaf hopper, *Empoasca* sp. were placed in one cage. In the second were added all other kinds of insects collected from neighboring beans. No insects were placed in the third which was left as a check for the effects of double shading.

In the first cage the disease began to be apparent on the fifth day after the introduction of Empoasca leaf hoppers. All of the cages were,

[4]Described as *Empoasca fabalis* n. sp. DeLong: A New Species of Bean Leafhopper from Haiti. Can. Ent. 62: 92–93, 1930.

Plate 32

1, Jackson Wonder Beans being grown both in a leaf hopper proof cage and in the open. Those outside are seriously affected by the yellows disease; 2, A twig of Kentucky Wonder beans showing the dwarfed, discolored, and distorted membrane accompanying the yellow diseases; 3, A large native bean, "Pois maldioc" showing the discoloration presumably of this disease; 4, Red bean twigs, (Pois rouge of Haiti) showing marked dwarfing and curling as occurs in susceptible varieties due to the yellows disease; 5, Kentucky Wonder beans growing in the open heavily infested with *Empoasca* and seriously affected by the yellows disease; 6, Jackson Wonder foliage and pods showing yellows disease on both. Note the difference in effect on the foliage in different varieties by comparison with Figs. 2 and 4.

however, left for several days for observing further developments. The disease progressed very rapidly in the first cage, whereas not the slightest symptom appeared in the second and third small cages or on the other beans in the large outer cage. These experiments were repeated in July and August with the same results. Bean aphids, other bean leaf hoppers, bean leaf beetles and bean red spiders failed to transmit the disease in these experiments.

The *Empoasca* leaf hoppers used in these experiments were collected from neighboring beans, many of which were badly affected by the "yellows." It would be desirable to know whether this species of leaf hoppers would transmit or induce the disease if they had never fed on plants showing symptoms of this disease, but this species of Empoasca could not be found except on garden plants, and beans were always nearby.

c. The effects of environmental conditions, such as the winter season and high altitudes has been mentioned in the discussion of economic considerations. It is thought that such effects might be a response to lower temperature. Facilities for artificially controlling the temperature were not available. However, the effects of partial and complete shading were tested.

The shade provided by double cages of very fine mesh brass cloth did not inhibit the development of the disease in the experiments described above. Likewise beans grown in the lath house and under the partial shade of interplanted crops, such as cotton and manioc, appeared to exert no inhibiting influence.

Plants under complete shade naturally became anemic and made no development except near the margin of the shaded areas, where the disease developed as severely as on non-shaded plants.

d. During the month of June seed procured from very severely diseased plants was planted and grown under cages as described above. They produced normal healthy plants, whereas seed planted in the open became diseased very soon after the young plants emerged from the soil. This experiment was repeated a few weeks later with the same results which clearly indicated that the disease was not seed borne.

e. *Varietal susceptibility.* Forty-two varieties of beans, several varieties of peas and related plants were tested for varietal susceptibility during the month of August. Included therein were the most common varieties obtainable from well known seed houses as well as the native grown "Pois rouge" and "Pois maldioc" (*Canavalia ensiformis*).

Ten days after planting, seven of the bean varieties showed unmistakable symptoms of the disease. Within a period of ten days more, practically all of the common beans had become affected. Very marked differences in varietal susceptibility were apparent, ranging from complete susceptibility as shown by the death of the plants shortly after the seedling stage, to a very high tolerance of certain varieties which produced a moderate yield of pods.

Of the common bean (*Phaseolus* spp.) Henderson's Bush Lima and Jackson Wonder proved the most resistant of the varieties tested. The common "Pois rouge" of Haiti was very susceptible, altho it was not

killed quite so readily as Black Valentine. The common cow pea of Haiti has been found to be sufficiently resistant so that it can be grown with fair results on the low lands during the summer season. A few cases have been observed where considerable areas have been markedly stunted following unusually heavy infestations of the Empoasca leaf hoppers. Velvet beans show distinct symptoms of the disease without however suffering any apparent deleterious effects. "Pois Maldioc" was almost immune to the disease, only a small proportion of the plants showing any distinguishable symptoms (Pl. 32, fig. 3) and marked stunting effects were not apparent on any great number of such affected plants, except when attacked at an early stage of growth.

The symptoms varied markedly on different varieties and species of plants. The first manifestations were usually a curling of the leaves downward, generally accompanied by a slight yellowing at the margin of the leaves. As the disease progressed, the yellowing became more pronounced. In some varieties the veins and petioles became yellow while the intervening leaf tissue was still green; in other varieties the veins and petioles were the last portions of the leaf to become yellowed; in other varieties the leaves became almost white and the plant rapidly assumed an anemic condition rather than the typically dwarfed, "mosaic" appearance.

In very susceptible varieties necrosis rapidly followed, progressing variously in the different varieties. Jackson Wonder and Henderson's Bush Lima showed yellow mottled areas with little necrosis following, but stunting effects were quite apparent (Pl. 32, fig. 4). It appeared likely that a yellow condition of adjacent peanuts infested with the same leaf hoppers was related to the bean yellows.

In summarizing the symptoms, it appears that a yellowing, whatever may be its extent or distribution in the leaves, is a general symptom. Marked necrosis (tipburn or hopperburn symptoms) is not common except in very susceptible varieties; leaves may or may not be crinkled and distorted. The leaves of Jackson Wonder (Pl. 32, figs. 1, 6) show the least curling of any variety, but other varieties show less curling when grown in the shade than when grown in the sun.

f. Experiments were made to test the possibility of artificially transmitting the disease from badly affected plants to healthy plants growing in wire cloth cages. Juice from diseased foliage was injected into wounds in the stems near the growing point and into the leaves and petioles. Repeated experiments gave negative results.

g. *Control experiments* After demonstrating the relationship of the small green bean leaf hopper, *Empoasca* sp. to bean yellows, it was thought that spraying with Bordeaux mixture might be an effective preventive of the disease.

Three attempts have been made to do this but in no case was yellows prevented. However, the earlier spraying operations were open to some criticism, since in the first attempt, the first spraying was delayed until the beans had already been fed upon by leaf hoppers and in the second, the interval between sprayings was occasionally too great. Final tests in March 1930, in which a plot of "red beans" was sprayed

weekly with Bordeaux mixture 4–8–50 and a similar plot was sprayed at the same time with Nicotine sulphate, 1 teaspoonful to a gallon of water, were unsuccessful as control measures in both cases. The nicotine plot had approximately the same numbers of leaf hoppers and "yellows" as the check plot had. The Bordeaux sprayings reduced the numbers of leaf hoppers and the amount of "yellows" somewhat, but not to the point of control. We have, therefore, been unsuccessful in all attempts at controlling the leaf hoppers and the disease by spraying. Selection for resistance probably offers the best promise in Haiti.

CONCLUSIONS. We conclude from these observations:

1. That the bean yellows disease described herein on various varieties of beans and several related plants in Haiti, is caused by the feeding of a small green leaf hopper, *Empoasca* sp. Whether this disease is a virus transmitted by the leaf hopper, or whether it is a reaction from certain fluid injected while feeding, was not determined, because no leaf hoppers which were definitely known not to have fed previously on beans could be obtained;

2. That no other insects occurring on beans during these studies caused the yellows disease to develop;

3. That the disease can be induced on healthy plants at any stage by merely lifting the cages and exposing them to the leaf hoppers or by placing leaf hoppers of this species on the beans;

4. That the disease is not transmitted through the seed. Beans grown from the seed of plants seriously affected, if kept free from leaf hoppers, produce normal plants at any season without signs of the disease;

5. That the disease was not transmissible through ordinary plant pathological inoculation procedure;

6. That all varieties of beans are attacked, but marked differences occur in varietal susceptibility ranging from complete susceptibility as evidenced by early death to a high degree of resistance with the production of a moderate crop. The Lima bean group belongs to the latter category; and

7. That control by spraying with Bordeaux mixture and nicotine sulphate was not obtained and if prevention of the disease is possible at all it will likely be difficult.

PETROLEUM INSECTICIDES

By C. W. Woodworth, *Berkeley, Calif.*

Kerosene emulsion was for a long time the standard, and almost the sole, insecticide, of this class. Heavy oils had been used in a small way in California and elsewhere for many years, but remained of minor importance and were not safe on foliage. My former student and assistant, Mr. W. H. Volck, introduced the highly refined heavy oils which, during the last few years, have sprung into such prominence, being now produced in large quantities by more than a score of manufacturers. Only the arsenicals have now a larger place and the prospect is that the heavy oils will shortly become the chief of the insecticides.

The heavy oils really constitute a new insecticide strikingly different in most particulars from kerosene as is shown in the following table which points out the more striking characteristics of the leading classes of insecticides arranged according to their economic standing, except that kerosene should be at the end of the list instead of next to the heavy oils where it was placed to bring out more clearly the differences between the two types of petroleums.

Chief Classes of Insecticides

	Arsenicals	Heavy oils	Kerosene	Sulphur	Cyanide	Nicotine
Toxicity:						
General	x	–	x	–	–	–
Selective	–	x	–	x	x	x
Nature of Poison:						
Nerve	x	–	x	–	x	x
Systemic	–	x	–	x	–	–
Place of Absorption:						
Stomach	x	–	–	–	–	–
Tracheae	–	x	x	x	x	x
Recovery by:						
Crisis	–	–	x	–	x	x
Lysis	x	x	–	x	–	–

The distinctions made in the above table are not rigorously true since there are differences of susceptibility even in the case of such a general poison as an arsenical and likewise in every other item of the table the distinctions are relative rather than exclusive, tho' expressing real and important differences. It is to be expected that presently there will be available heavy oils that differ strikingly from the characteristics indicated in the table, because the possibilities of this type of insecticide is still largely an unexplored field. We may expect the development of a family of petroleum insecticides, including the present kerosene and heavy oil with intermediate members and others different from both.

There are over a hundred brands of heavy oils now on the market, but these do not represent many distinct types and there is considerable variation in the oils selected for the manufacture of some of the commercial brands. The control laboratories generally distinguish the (1) *miscible oils* made with a cresol soap; (2) *the soap emulsions* made with ordinary soaps; and (3) the *non-soap emulsions*, the most common emulsifier being an alkaline caseinate. The more important distinction, however, is the character of the oil employed. The three types are (1) the *Kerosenes* with gravity of about 40° Baume, constituting probably not over 2% of the trade; (2) *Summer oils* with a gravity about 30° and (3) the *Crude* and *Winter* oils with a gravity around 20°. The crude oils consist of a mixture of oils having a wide range of gravity, while those sold as winter oils are distillates in which both the lighter and heavier fractions have been removed and some of them approach the summer oils both in gravity and refinement.

Manufacturers commonly classify their summer oils as *heavy*, *medium*, and *light*, following the practice of the lubricating oil trade for oils of similar viscosities. These terms are completely misnomers, since those denominated *heavy* and *light* may have precisely the same gravity. There is no reason for entomologists to perpetuate this inaccuracy and the terms *thick* and *thin* are introduced as substitutes for heavy and light.

The following table gives in round numbers the average physical characteristics of the winter oils and three grades of summer oils compiled from the data published during the last two years by the California State Department of Agriculture:

Type	Gravity Baume	Viscosity Saybolt	Sulfonation	Distillation 350°	325°	Evaporation 24h	6h	2h
Winter oil	22°	110 sec.	68%	40%	15%	——	——	——
Thick oil	29°	110 sec.	97%	30%	10%	55%	35%	20%
Medium oil	30°	80 sec.	95%	50%	20%	65%	45%	30%
Thin oil	31°	60 sec.	93%	75%	25%	85%	60%	40%

It is quite conceivable that not one of the physical data shown in the table above, by which we now strive to characterise and differentiate between these oils has any real significance in determining their efficiency as insecticides. We only know that California petroleums with quite an amount of variation in their physical characteristics exhibit a remarkable efficiency. It is in this State that the large use of these oils originated and where they have been most thoroughly tested. Whether oils produced in a similar manner from crude oils with a paraffin base will show similar characteristics to our asphalt base oils has not been sufficiently demonstrated.

The insecticidal effect of an oil depends on the very small quantity of the material that is absorbed by the blood after finding its way into the tracheae of the insect. This absorbable ingredient, may be very small in amount, but is the essential element and it may be that all of the measured physical qualities merely indicate the character of the predominating non-absorbable, and therefore non-effective, portion of the oil, the menstrum in which the effective biolyte is dissolved.

The amount of oil that penetrates a leaf is probably much greater relatively than that which enters an insect and the effects on a plant are also easier to study. The following is an attempt to organize our knowledge concerning oils and plants:

TENTATIVE CLASSIFICATION OF THE OIL EFFECTS ON PLANTS

MECHANICAL—increasing with high viscosity and low evaporation
1. Softening of the bark and bud scales
2. Changing appearance of fruit with bloom
3. Reduction of cuticular evaporation, giving protection from desiccating winds (after initial chemical effect is past).
4. After the penetration of the walls of the guard cells, there may be excessive evaporation through the stomata.

CHEMICAL—depending on the chemical ingredients of the oil. These are grouped in three series:
Paraffins—Lower members of the series are more general poisons. The higher members are practically inactive and in the heavy spray oils now on the market constitute only the menstrum carrying the unsaturates of the following series.
Olefins aromatics—Many of the higher members are special drugs or poisons and much more active.
There is a very slow translocation even of the denser oils and consequently a slight physiological effect, but the nature of the more evident actions consists in:
(A) Modification of the action of certain *enzymes:*
1. Increasing hydrolysis, initial and local—
(a) dropping of leaves and fruit; afterward the general effect is—
(b) growth stimulation; reduction of quantity of fruit buds, and
(c) early opening of buds in the spring (See also 1 under *Mechanical* effect);
2. Decreasing oxidation, thus delaying—
(a) ripening of fruit;
(b) coloring of lemons; and
(c) coloring of autumn leaves.
(B) Biolysis of the *protoplasm*, followed by excessive oxidation showing as:
(a) browning of the leaves or parts of leaves or fruits;
(b) dying of tips of twigs; and
(c) death of spots on roots or bark.
This class, with the common end points just enumerated above, can be subdivided according to preliminary symptoms indicating differences of the chemical action of the biolytes.

Hastening conditions:
- Low viscosity permitting rapid penetration.
- High temperature producing low viscosity in the oil.
- Dry condition of leaves permitting ready penetration.
- Quick breaking of the emulsion.

Intensifying conditions:
- Slow evaporation giving a long time for penetration.
- Low temperature reducing the rate of evaporation.
- High concentration of spray.
- Special susceptibility of the plant.

The terms *biolysis* and *biolyte* used above are, I believe, new in entomological literature. These words in their various forms will prove very useful; thus, *biolyte* is the general term for insecticides, fungicides, etc., *biolysis* is the killing of pests, and the science of economic poisons is *biolytology.* When studying the nature of biolytes, it will commonly be desirable to employ lower concentrations reducing a biolyte to a biostroph. Most of the items in the above classification are biostrophic and they are by no means all injurious.

Petroleum oils open to us a new and very difficult field for research, but one which promises more at the present time for the advancement of economic entomology and of the whole subject of biolytology than any other. It involves the most thorough-going investigation of the biastrophic action of the almost innumerable hydrocarbon compounds found in petroleum oils, either in nature or after synthetic manipulations. This study must be made on all classes of living organisms. Out of this study we may expect the emergence of a series of biolytes better than we now have and perhaps sufficient to meet all the needs of pest control.

The control laboratories have thus far assumed that physical or chemical determinations are adequate to measure the biolytic value of spray material, but they are certain to be forced by the development of organic biolytes to turn to methods of making tests on living organisms, for many of these biolytes may prove to be as elusive as are the vitamines.

EXPERIMENTS WITH INSECTICIDES AGAINST CATTLE GRUBS, *HYPODERMA* SPP.

By F. C. Bishopp, E. W. Laake, R. W. Wells, and H. S. Peters,[1] *Bureau of Entomology, U. S. Department of Agriculture*

Abstract

Results are presented of tests of single and repeated applications of various insecticides against cattle grubs, *Hypoderma* spp., when applied to the backs of cattle. These supplement similar tests reported in an earlier publication. Special attention was given to the use of insecticides in dust form. Ground derris root and carriers containing derris extract were tried under varying conditions, and excellent results were obtained, Tobacco powders and dusts containing free nicotine and nicotine sulphate were also extensively used and gave a high degree of control.

An increased realization of the heavy losses which are being sustained in many parts of the world from the attacks of cattle grubs, *Hypoderma lineatum* De Villers and *Hypoderma bovis* DeGeer, makes desirable more extensive investigations of these insects and of various methods of combating them. Work thus far accomplished indicates that the most practical control measures are those directed against the larval stages in the cysts beneath the skin of the backs of the cattle, since here the insect is most accessible to attack.

Hand extraction is a comparatively simple operation in some cases and is being rather extensively practiced, but it has distinct limitations. In the first place, it is disagreeable work and the cattle are more or less restless and excited during the ordeal. In the second place, in the case of certain breeds and individuals it is very difficult to remove the grubs without the use of forceps; and in the third place, there is danger, especially in the case of animals from which extraction is difficult, that abscesses will be induced by the crushing of the larvae or the bruising of the tissues, or that the proteins in the bodies of the grubs, entering the general circulation in large quantities, may produce anaphylaxis.

These objections are largely met by the application of insecticides to the backs of the cattle. In Europe as well as in this country marked interest has been shown in recent years in such treatment for the control of cattle grubs. There seems to be a tendency, however, in European countries to turn to patented mixtures rather than to develop simple insecticides which are readily available and not controlled by proprietary interests.

[1]The following members of the staff of the Bureau of Entomology have aided materially: W. G. Bruce, H. M. Brundrett, E. C. Cushing, D. G. Hall, J. F. Krueger, J. L. Webb, and also Mr. C. C. Compton of the Office of the State Entomologist of Illinois.

The Insecticide Division of the Bureau of Chemistry and Soils cooperated by making analyses of several of the insecticides used and by preparing the rotenone dusts.

METHODS OF PROCEDURE. The experiments reported upon in this paper were conducted in New York, Texas, and Vermont during the years 1925 to 1929, inclusive, on dairy cattle, mainly of the Jersey and Holstein breeds. The treatments were applied in barns, and in most cases the cattle were kept in the open except during milking hours. These experiments supplement those presented in 1926,[2] and, as in the tests reported therein, have been carried out under widely varying conditions as regards breed, age, and condition of host, climate, housing, etc. The methods of procedure in applying the treatments and in recording the results, however, have been made as nearly uniform as possible.

TESTS OF SINGLE APPLICATIONS OF INSECTICIDES AFTER DETERMINING THE INSTAR OF EACH GRUB. To obtain exact information on the toxicity of various materials to cattle grubs in each accessible stage of development and to make the data comparable with similar information reported on pages 94–97 of Department Bulletin 1369 (see footnote 2), tests of a number of materials were made on grubs, the instars being determined immediately before treatment. The infested cattle were first numbered individually and the location of each grub was then indicated on a diagram of the back of each animal. Each grub was marked by clipping a lock of hair from the animal a short distance below it. The stage of development was then determined with little disturbance of the grub, and the insecticide carefully applied to each grub hole. To determine the larval instars it is often necessary to clean out the openings in the skin of the cattle. This also allows the grubs to be reached more easily by the insecticide, and greater efficiency is obtained than under practical conditions where these openings are not cleared. Five or six days after treatment the grubs were carefully removed from the cysts and their condition determined. A small percentage of the grubs found alive at the time of examination would probably die later as shown in other tests. The major effects could best be determined, therefore, at that interval after treatment.

The results of these tests are presented in Table 1. At the time of checking results some of the grubs that had not been killed had matured and escaped. Others which had been killed may have been expelled. These are accounted for in the column headed, "Number of grubs not found." It will be noted that more grubs had disappeared in the case of treatments with materials of low toxicity than with those of high toxicity. This was to be expected, as, naturally, some of the injured

[2]Bishopp, F. C., Laake, E. W., Brundrett, H. M., and Wells, R. W. The Cattle Grubs, or Ox Warbles; Their Biologies and Suggestions for Control. Dept. Bull. 1369, U. S. Dept. of Agr., 119 p.

TABLE 1. TESTS OF INSECTICIDES AGAINST HYPODERMA SPP. IN BACKS OF CATTLE—SINGLE APPLICATION AFTER DETERMINING INSTAR OF GRUBS

Item No.	Material and strength used	Number of cattle treated	Number of grubs treated	Number of grubs dead, Instar 3	Number of grubs dead, Instar 4	Number of grubs dead, Instar 5	Number of grubs alive, Instar 3	Number of grubs alive, Instar 4	Number of grubs alive, Instar 5	Number of grubs not found	Per cent dead based on dead and alive only (excluding grubs not found)	Per cent dead based on all grubs treated: If all grubs not found are considered as dead	Per cent dead based on all grubs treated: If all grubs not found are considered as alive
1	Cube root, powdered, 100-mesh, per cent rotenone unknown	11	116	0	40	76	0	0	0	0	100	100	100
2	Derris root, powdered, per cent rotenone unknown	9	115	0	22	92	0	0	1	0	99.1	99.1	99.1
3	Derris root, powdered, 0.5 per cent rotenone	56	204	0	26	152	0	4	22	0	87.2	87.3	87.3
4	Derris root, powdered, 1.35 per cent rotenone	76	301	0	14	210	0	4	55	18	79.1	80.4	74.4
5	Derris root, powdered, 2.3 per cent rotenone	38	251	2	28	146	0	29	46	0	70.1	70.1	70.1
6	Derris tailings, per cent rotenone unknown	22	88	0	14	37	0	8	29	0	57.9	58.0	58.0
7	Derris powder from which rotenone has been extracted with ether	18	80	0	0	22	0	1	44	13	32.8	43.8	27.5
8	Derris extract, 1 per cent rotenone (pure) in kaolin	20	111	0	4	78	0	1	21	7	78.8	80.2	73.9
9	Derris extract, 2 per cent rotenone (pure) in kaolin	24	156	0	24	108	0	1	1	2	98.5	98.5	97.1
10	Derris extract, 2.3 per cent rotenone (pure) in kaolin	18	107	0	8	99	0	0	0	0	100.	100.	10.2
11	Derris extract, 2.4 per cent crude rotenone in kaolin	23	141	13	69	24	2	27	6	0	75.2	75.2	75.0
12	Derris extract, 10 per cent crude rotenone in kaolin	18	220	9	99	107	0	4	1	0	97.7	97.7	97.7
13	Derris extract ointment, 1 per cent derris resins plus other ingredients (proprietary)	24	226	0	70	150	0	1	3	2	98.2	98.2	97.3
14	Derris resins, 3 per cent in petrolatum (ointment)	26	117	0	5	84	0	1	2	25	96.7	97.4	76.1
15	Dipyridyl sulphate, 28 per cent, equal parts with water	22	113	0	7	22	0	1	66	17	30.2	40.7	25.7
16	Dipyridyl sulphate, 8 per cent, in dust	20	141	0	0	4	0	3	108	26	3.5	21.3	2.8
17	Kaolin, powdered	36	128	0	0	0	0	17	83	28	0	21.9	0
18	Nicotine (free), 1 per cent in hydrated lime	7	87	3	27	22	0	32	3	0	59.8	59.8	59.8
19	Nicotine (free), 2 per cent in hydrated lime	55	402	6	76	270	1	38	11	0	87.6	87.6	87.6
20	Nicotine (free), 3 per cent in hydrated lime	20	273	6	75	127	0	55	10	0	76.2	76.2	76.2
21	Nicotine (free), 3 per cent in tripoli earth	15	118	0	20	83	0	12	3	0	87.3	87.3	87.3
22	Nicotine sulphate, 3 per cent in kaolin	92	275	1	17	198	0	2	21	36	90.4	91.6	78.5
23	Nicotine sulphate, 3 per cent in cream silica earth	11	117	1	9	85	0	18	4	0	81.2	81.2	81.2

24 Paradichlorobenzene, 1 part, petrolatum, 5 parts (ointment)	46	211	25	29	27	4	54	72	0	38.4	38.4	38.4
25 Pyrethrum extract, 0.155 per cent oleo resin, plus soap and water (proprietary)	9	106	0	21	17	0	31	37	0	35.8	35.8	35.8
26 Pyrethrum extract, 0.166 per cent oleo resin, plus soap and water (proprietary)	11	118	0	16	4	0	33	65	0	16.9	16.9	16.9
27 Sulphur, so-called colloidal, recovered in manufacture of artificial gas	13	110	2	14	10	1	30	53	0	23.6	23.6	23.6
28 Tobacco powder, natural, 1 per cent nicotine, 80-mesh	30	211	7	31	96	1	40	33	3	63.8	64:9	63.
29 Tobacco powder, alkalin, 2.8 per cent nicotine, 80-mesh	14	132	3	26	74	1	21	7	0	78.0	78.0	78.0
30 Tobacco powder, natural, 3.04 per cent nicotine, 200-mesh	31	138	0	9	56	0	76	47	0	47.1	47.1	47.1
31 Tobacco powder, natural, 3.16 per cent nicotine, reground	34	232	1	30	192	0	4	2	3	97.4	97.4	96.1
32 Tobacco powder, natural, 3.16 per cent nicotine, not reground	9	109	4	24	39	0	37	5	0	61.5	61.5	61.5
33 Tobacco powder, natural, 5 per cent nicotine, 80-mesh	26	143	8	54	70	0	2	9	0	92.3	92.3	92.3
34 Tobacco powder, alkalin, 4.48 per cent nicotine, 80-mesh	45	128	0	5	92	0	4	13	14	85.1	86.7	75.8
35 Tobacco powder, natural, 8 per cent nicotine, 80-mesh	32	123	0	3	85	0	8	16	11	78.6	80.5	71.5
36 Tobacco powder, with free nicotine added, 3.19 per cent nicotine, reground	7	78	1	20	45	0	11	1	0	84.6	84.6	84.6
37 Tobacco powder, with free nicotine added, 3.18 per cent nicotine, not reground	11	98	1	32	43	0	19	3	0	77.6	77.6	77.6
38 Tobacco powder, with nicotine sulphate added, 3.06 per cent nicotine, reground	3	83	3	24	52	0	2	2	0	95.2	95.2	95.2
39 Tobacco powder, with nicotine sulphate added, 3.01 per cent nicotine, not reground	9	107	3	24	40	1	22	16	1	63.2	63.6	62.6
40 Tobacco, coarse ground, plus bentonite, 4 per cent nicotine (proprietary)	45	122	0	2	77	0	5	29	9	69.9	72.1	64.8
41 Tobacco ointment (1 part powder, natural, 1 per cent nicotine to 4 parts petrolatum)	8	105	1	28	39	0	32	5	0	64.8	64.8	64.8

grubs would complete development and leave the host. In the table the percentage of kill is computed on three different bases. The figures in the last column, "Per cent dead based on all grubs treated, if all grubs not found are considered as alive," give the lowest kill which could have occurred in these tests.

The greater efficacy of derris powders with the higher rotenone content clearly shows the insecticidal value of that material. The figures for the three grades of derris powder (powdered derris root) may be somewhat confusing. The smaller percentages of kill obtained with the powders containing the higher percentages of retenone may be explained by the physical condition of these powders. They were in shredded condition, which precluded the possibility of working them into the holes of the grubs satisfactorily. The results secured with derris powder from which the rotenone had been exhaustively extracted with ether would seem to show either that a very small quantity of rotenone remained, although enough to kill some of the larvae (27.5 per cent), or, what is more likely, that other derris compounds not extracted by ether have some toxicity to cattle grubs. The tests with powders consisting of kaolin containing 1, 2, or more per cent rotenone indicate that the 1 per cent strength is insufficient to give satisfactory results, but that the other two strengths gave almost a complete kill under the conditions described. "Cube" root should be considered with derris compounds, as it has recently been shown by Clark[3] to contain rotenone. In fact, in the samples examined by the Bureau of Chemistry the rotenone content ran from 5 to 10 per cent, uniformly higher than that in derris.

The control effected with free nicotine and nicotine sulphate, 2 to 3 per cent in a carrier, was fairly satisfactory throughout. Apparently there is little difference between the effectiveness of free nicotine and that of nicotine sulphate, when these are used in hydrated lime, tripoli earth, kaolin, or cream silica. There are practical objections, however, to the utilization of lime as a carrier, as is pointed out later in this paper. Tripoli earth is more satisfactory as a carrier than kaolin, which has a tendency to form small pellets and does not penetrate the hair so well. The results obtained in the tests of tobacco powders made from natural tobacco were somewhat erratic. The tests with the tobacco powder containing 3.1 per cent nicotine and with the same material which was reground (Items 31 and 32) would seem to show that the fineness, in this particular case at least, was an important factor, the reground powder giving a kill of 96.1 per cent as against 61.4 per cent with the

[3]Clark, E. P. The occurrence of rotenone in the Peruvian fish poison "Cube." Science (N. S.), Vol. 70. p. 478, Nov. 15, 1929.

other. Paradichlorobenzene in petrolatum (Item 24), recommended and rather extensively used in cattle-grub control work in France, is shown by the writers' tests to have little value, the kill being only 38.4 per cent. More finely pulverized crystals of paradichlorobenzene might give better results, as it was found difficult to pulverize them and to mix them thoroughly in the ointment.

Tests of Insecticides Applied Without Examining Grubs Before Treatment. In another series of tests the grubs were undisturbed, being left in their natural condition and undoubtedly more protected from the action of the insecticide than in the experiments reported in Table 1. The insecticides were applied with a shaker can, and the material was lightly rubbed into the hair, simulating the type of application which the average farmer would make. The quantity of material used varied greatly in the different tests, partly because several different men made the applications, a factor undoubtedly responsible to some extent for the great variation in the results indicated in Table 2.

Although the quantity of insecticide used was not determined in all tests, it is clear from the records kept that an insufficient quantity was employed to get the best results. For instance, in the test of nicotine sulphate, 3 per cent in tripoli earth, against *H. lineatum* (Item 6), the material was applied at the rate of 0.71 ounce per animal, or 7.3 ounces per 100 grubs. The much lower kill secured with natural tobacco powder, 3.17 per cent nicotine (Item 8) would be explained by the fact that only 0.19 ounce was used per animal, or 2.1 ounces per 100 grubs.

Tests of Periodic Applications of Insecticides. In the tests of periodic treatments, as reported in Table 3, the grubs were not disturbed nor were the holes cleaned out. On the sixth and twelfth days after applying each treatment, the grubs were examined with as little disturbance as possible to determine whether they were dead or alive. Thus in the tests with 15-day intervals between treatments the second examination preceded the subsequent applications by three days. This allowed the living grubs to resume normal conditions by the time the following applications were made.

These tests were carried out in the vicinity of Dallas, Texas, beginning about December 1, when some of the grubs were mature, although young ones were still coming up. From two to four applications of the dusts were made during the period of test, the animals being practically free of grubs after that number of treatments had been given. Only those cattle which were infested were treated, and the applications were confined largely to the grubs; that is, the entire back of an animal was not dusted. A comparatively small percentage of the grubs was

TABLE 2. TESTS OF INSECTICIDES AGAINST HYPODERMA SPP. IN THE BACKS OF CATTLE; INSTAR OF GRUBS NOT DETERMINED BEFORE TREATMENT

Item No. Material and strength used	Number of cattle treated	Number of grubs treated	Number of grubs dead Instar 3	Number of grubs dead Instar 4	Number of grubs dead Instar 5	Number of grubs alive Instar 3	Number of grubs alive Instar 4	Number of grubs alive Instar 5	Number dead but stage not determined	Number of grubs not found	Per cent dead, based on dead and alive only (excluding grubs not found)	Per cent dead based on all grubs treated: If all grubs not found are considered as dead	Per cent dead based on all grubs treated: If all grubs not found are considered as alive
Hypoderma bovis													
1 Derris root, powdered, 0.5 per cent rotenone	25	102	0	0	81	0	0	4	7	10	95.7	96.1	86.3
2 Derris extract, 2.4 per cent crude rotenone in kaolin	46	197	0	0	38	0	0	61	63	35	62.3	69.0	51.3
3 Nicotine(free), 3 per cent in hydrated lime	37	101	0	0	64	0	0	20	1	16	76.5	80.2	64.4
4 Sulphur, so-called colloidal, recovered in manufacture of artificial gas	15	57	0	0	6	0	0	32	8	11	70.0	43.9	24.6
5 Tobacco powder, natural, 4 per cent nicotine, 200-mesh	38	125	0	6	31	0	0	53	8	27	45.9	57.6	36.0
6 Tobacco powder, natural, 4 per cent nicotine, 80-mesh	26	90	0	0	29	0	1	37	8	15	49.3	57.8	41.1
7 Tobacco powder, alkalin, 4 per cent nicotine, 80-mesh	49	177	0	0	56	0	1	51	35	34	63.6	70.6	51.4
8 Tobacco powder, coarse, natural, 4 per cent nicotine plus bentonite(proprietary)	40	94	0	0	52	0	3	24	0	15	65.8	71.3	55.3
9 Tobacco powder, natural, 6 per cent nicotine, 200-mesh	29	104	0	3	21	0	2	49	6	23	55.6	51.0	28.8
10 Tobacco powder, natural, 8 per cent nicotine, 80-mesh	21	101	0	1	62	0	0	11	3	24	84.6	89.1	65.3
11 Tobacco powder, alkalin, 8 per cent nicotine, 80-mesh	34	108	0	6	57	0	1	16	12	16	81.5	84.3	69.4

Hypoderma lineatum													
1 Derris root, powdered, 1.35 per cent rotenone	49	405	0	30	50	2	121	93	87	22	43.6	46.7	41.2
2 Derris root, powdered, 2.3 per cent rotenone	10	92	0	5	23	0	6	14	42	2	77.8	78.3	76.1
3 Nicotine (free), 3 per cent in tripoli earth	16	222	1	14	130	0	28	11	21	17	81.0	82.4	74.8
4 Nicotine (free), 3 per cent in cream silica earth	22	140	0	14	93	0	18	6	5	4	82.4	82.9	80.0
5 Nicotine (free),3 per cent in hydrated lime	22	210	2	19	94	0	30	13	29	23	77.0	79.5	68.6
6 Nicotine sulphate,3 per cent in tripoli earth	18	176	0	4	132	0	10	17	4	9	83.8	84.7	79.5
7 Pyrethrum powder, best grade, over 80 per cent passing through 170-mesh sieve	26	289	0	6	24	0	14	135	63	47	38.4	48.4	32.2
8 Tobacco powder, natural, 3.17 per cent nicotine	24	215	1	30	35	0	89	13	47	0	52.5	52.6	52.6
9 Tobacco powder, 6.06 per cent nicotine, 200-mesh	24	163	1	33	26	0	47	11	45	0	64.4	64.4	64.4

alive and still present when the second application was made, and practically none received the third treatment.

The percentage killed, as indicated in the last column, is the minimum, as some few of the grubs recorded as gone were probably killed, although all of those so recorded were considered as living in figuring the percentages. It is noteworthy that the kill secured with derris when applied at 15-day intervals (Item 1) and with nicotine dust, 3 per cent in lime (Item 6), is almost complete. The derris applications at 30-day intervals did not give as good results as would be expected from ground root with a rotenone content of 1.35 per cent. This may be explained by the physical condition of this powder. The same material was used as in the tests recorded in Table 1 (Items 4 and 5), in which case a rather low efficacy was noted as compared with the derris powder of proper physical condition and containing .5 per cent rotenone (Item 3).

TABLE 3. TESTS OF PERIODIC APPLICATIONS OF INSECTICIDES AGAINST *Hypoderma lineatum* IN BACKS OF CATTLE

Item No.	Material and strength used	Number days between treatments	Number of cows	Number of grubs treated	Number of grubs dead	Number of grubs gone	Per cent of grubs dead (based on number treated)
1	Derris root, powdered, 1.35 per cent rotenone.	15	38	195	192	3	98.46
2	Derris root, powdered, 1.35 per cent rotenone.	30	28	344	292	52	84.88
3	Lime, hydrated.........	15	5	60	56	4	93.33
4	Nicotine (free), 1 per cent in lime..............	30	37	477	432	45	90.57
5	Nicotine (free), 3 per cent in lime..............	30	30	155	147	8	94.84
6	Nicotine (free), 3 per cent in lime..............	15	38	263	262	1	99.62
7	Tobacco powder, natural 1 per cent nicotine....	15	35	341	322	19	94.43
8	Tobacco powder, natural 1 per cent nicotine....	30	36	242	187	55	77.27
9	Tobacco powder, natural 1.29 per cent nicotine..	15	61	295	267	28	90.51
10	Tobacco powder, natural 4 per cent nicotine 200-mesh................	30	40	220	199	21	90.45
11	Tobacco powder, natural 4 per cent nicotine 200-mesh................	15	34	170	159	11	93.53
12	Tobacco powder, natural 8 per cent nicotine 200-mesh................	15	23	122	115	7	94.26

Attention is called to the fact that where the same materials were used at 15-day and at 30-day intervals, the shorter interval gave an

increase in the percentage of kill, ranging from 3.08 per cent in the case of tobacco powder containing 4 per cent nicotine (Items 10 and 11)to 17.16 per cent in that of tobacco powder with a nicotine content of 1 per cent (Items 7 and 8). The high degree of control effected by the use of hydrated lime (Item 3) is surprising, although the number of grubs treated was too small to give reliable results. Lime used alone, or even as a carrier, is objectionable because of its irritation to the throat of the operator and the somewhat drying and caustic effect it has on the skin of the cattle.

It is desirable to kill the grubs while young so that their adverse effect on the host may be terminated as soon as possible and their bodies may be more promptly disposed of by the host. Unfortunately, the killing power of powders is somewhat lower in the case of the younger stages than in that of the older ones, apparently because of the difficulty of getting the material through the small apertures and into the cysts. This fact and the tendency for farmers to miss some of the grubs when applying treatments make it advisable to give the treatments more frequently than would appear necessary on the basis of the life history of the insect. Probably the 15-day period would be better than the 30-day interval. The treatments should begin when the earliest grubs reach the fifth instar. This date would vary greatly in different sections and even in different seasons. The data on the seasonal history of cattle grubs as given in Department Bulletin 1369, pages 74–79, should serve as a general guide to those contemplating the initiation of control operations.

METHODS OF APPLYING INSECTICIDES AND THEIR EFFECT ON CATTLE. It will be noted that special attention has been devoted to insecticides applied in dust form. Although certain washes and ointments have given excellent results, the authors feel that the application of dusts is more simple, especially in the case of cattle in pens or chutes. Furthermore, the wetting of the backs of the cattle is objectionable, particularly as the early applications must be made in winter.

Some owners of dairy herds favor the use of ointments, and this type of insecticide may be found to have a place, especially in the treatment of dairy herds. When ointments are used, some of the dead grubs are expelled from the cysts. This does not occur with insecticides applied as dusts or washes.

Thoroughness of application is of the utmost importance, regardless of the method employed. The material must actually enter the small holes in the skin to kill the grubs; hence it is necessary not only to apply it over each cyst but to work it well into the hair to insure getting some

into each hole. To make ointments effective they must be pressed into each hole, with the finger or otherwise.

The quantity of insecticide used is also of importance. If the material is carefully worked into each grub hole, less is required to get the same result than when a general and less thorough application is made. When the infestation is heavy, a general application is necessary. This is advisable also when farmers are doing the work, especially when the hair of the animals is long and thick. For such treatments two or three ounces per head is required. There may be some danger of toxosis to cattle from the general and heavy application of dusts containing 2 or 3 per cent of free nicotine. Although no injury was observed in these tests, it is known that the susceptibility of individual cattle to nicotine poisoning varies to a marked degree, and certain climatic conditions may also render the material more easily absorbed in quantity. As nicotine sulphate appears to have about the same killing power as free nicotine, the use of the former is advocated on account of its lower toxicity to the host. As a precaution, not more than 3 ounces of 2 per cent or 2 ounces of 3 per cent nicotine dust should be used on each animal. Natural tobacco powder is probably less toxic to the cattle than the dusts containing either free nicotine or nicotine sulphate, and would therefore be preferable from that point of view. If a tobacco powder of uniform physical condition and carrying about 2 per cent of nicotine could be made generally available at a comparatively low cost it would probably be a very satisfactory and practical insecticide for this purpose. No toxic effects on the cattle are to be expected from derris products, and they seem to have no deleterious influence on the skin. Some believe that it is not good practice to leave the dead grubs in the cysts. It should be pointed out, however, that in the rather extensive use of insecticides listed in this paper no injurious effects on the host have resulted from leaving the dead larvae in the cysts, except that occasionally the presence of the mature grubs may have retarded the healing of the holes in the skin.

The writers' experiments indicate that the condition of the skin, the length of the hair, and perhaps other host factors, as well as climatic conditions, may influence the results obtained from insecticidal treatments. A heavy winter coat of hair holds the material over the grubs and appears to favor their destruction, provided the insecticide is brought in close contact with the skin. On the other hand, such a condition of the hair often interferes materially with the application, and greater care is required to make it properly. The effect of insecticides on larvae which cut holes through the skin after the application has

been made has not been fully determined, but with some of the materials, at least, young grubs which cut holes through the skin several days after the insecticide has been applied are killed in a short time.

The authors believe the use of insecticides should be employed only where a concerted effort is being made to bring about a high degree of control. In such work, community action is desirable so that a very sharp reduction in the number of grubs will be brought about as a result of the first year's effort.

NEONICOTINE AND CERTAIN OTHER DERIVATIVES OF THE DIPYRIDYLS AS INSECTICIDES

By C. R. SMITH, *Bureau of Chemistry and Soils*, and C. H. RICHARDSON and H. H. SHEPARD, *Bureau of Entomology, United States Department of Agriculture.*[1]

ABSTRACT

Twenty-five dipyridyl derivatives and related compounds not previously reported have been prepared and tested as contact insecticides.

Neonicotine was the most toxic compound, comparing favorably in this respect with nicotine to which it is chemically similar.

In a previous publication (*1*)[2] the toxicity of "dipyridyl oil" prepared by the action of sodium on pyridine under conditions described by one of us (*2*) was compared with the dipyridyls isolated from the oil (alpha alpha, beta beta, beta gamma, and gamma gamma derivatives) and also with alpha beta dipyridyl prepared from a different source. The relatively high toxicity of the "dipyridyl oil" pointed to the presence of some other compound, probably a dipyridyl derivative, possessing high toxicity.

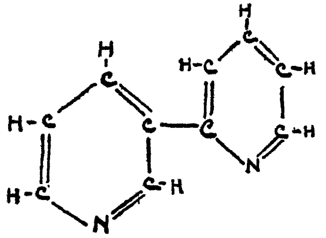
While the search for a method of separating the toxic compound was being made, the corresponding dipiperidyls (*3*) and certain of the pyridyl piperidines were prepared and tested with the idea that it might be one of these. The toxic compound, however, was finally prepared in the pure state and identified as beta pyridyl alpha piperidine. It was called neonicotine because its empirical formula is the same as that of nicotine and its toxicity is of the same order. The comparison, however, goes farther than this, as their chemical structure is very similar. It may be stated that no other possible pyridyl piperidine can compare

[1]The chemical work in connection with this subject is by Mr. Smith; the toxicity tests are by Dr. Richardson and Mr. Shepard. The authors are indebted to Mr. R. C. Burdette, who made some of the earlier tests.

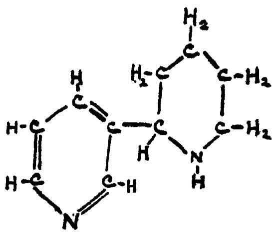
[2]Reference is made by number (italic) to "Literature cited," p. 867.

so closely to nicotine in structure as does neonicotine. Its toxicity is decidedly greater than that of any other dipyridyl derivative we have tested.

The detailed description of the chemical methods involved in the separation and identification of neonicotine from "dipyridyl oil" and the preparation of certain pyridyl piperidines will not be given here but will be published later by one of us. The dipyridyls, pyridyl piperidines, and the dipiperidyls are represented by the following types:

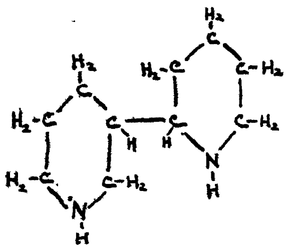


I αβ Dipyridyl

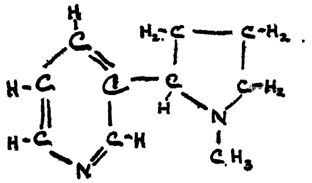


II β Pyridyl α piperidine (Neonicotine)

while nicotine is represented thus (iv):



III αβ Dipiperidyl



IV Nicotine (β-Pyridyl-α-N-methylpyrrolidine)

Neonicotine boils at 280–281° C. It forms a picrate crystallizing from water in prismatic needles which melt at 213° (cor.). On reduction with hydrogen in the presence of platinum black alpha beta dipiperidyl is produced. Neonicotine can be readily methylated by methyl iodide or potassium methyl sulphate. The ethyl and propyl derivatives have also been prepared and other alkyl derivatives are in the course of preparation. Neonicotine is soluble in water in all proportions. It is very much less volatile with steam than is nicotine.

When alpha beta dipyridyl is reduced with tin and hydrochloric acid the beta ring is reduced, thereby forming not neonicotine but isoneonico-

tine which has very much less toxicity than the former. A study of methods for the reduction of the alpha ring to produce neonicotine is in progress.

The toxicity of each compound was determined by a method previously described (*4*), *Aphis rumicis* L. being the test insect. The solutions or emulsions were sprayed on dwarf nasturtium plants (*Tropaeolum majus*) well infested with the aphids. The per cent of aphids killed and the condition of the plants were determined after about 24 hours. In the earlier tests 0.3 per cent sodium fish-oil soap was used as a spreader. In the previous paper just cited (*4*) it was stated that this spreader showed little killing at the concentration used. Probably owing to unavoidable differences in susceptibility of the aphids and to slight changes in the application of the method of determining toxicity after a period of years, 0.3 per cent sodium fish-oil soap in blank experiments made during the time of these studies has been found to kill about 45 per cent of the aphids. In view of the toxicity of this low concentration of soap, experiments were also made in some cases with 1 per cent saponin which kills only about 14 per cent of the aphids. In a recent paper (*5, p. 1008*) soap and saponin have been compared with respect to toxicity.

The criterion of tolerance of the plant to a compound was the same as that described in the papers just cited (*4, 5*). The figures for tolerance are based on observations upon tests with both spreaders. They may be considered, therefore, as of general significance only.

The following table presents the results of these experiments and includes for comparison previously published data on nicotine and the dipyridyls. The mortality in each case is given without attempting to make allowance for the toxicity of the spreading agent.

These studies have involved compounds in three series: (1) the dipyridyls, of which there are 6 isomers in which both pyridine rings of each compound are unsaturated with hydrogen; (2) the dipiperidyls, consisting of 6 isomers which correspond with the previous group and in each of which both rings are completely saturated; and (3) the pyridyl piperidines, of which there are 9 each with one ring unsaturated and the other saturated. Of the dipyridyls tested $\alpha\beta$-dipyridyl is the most toxic. Of the four dipiperidyls that are tested in the form of bases $\beta\gamma$-dipiperidyl shows the greatest toxicity. $\alpha\beta$-dipiperidyl as a base, however, might be more toxic, in which case the order of toxicity in each of the two series would be nearly the same for the various isomeric forms. The dipiperidyls are for the most part more toxic than the corresponding dipyridyls.

TABLE

Compound	Spreader, 0.3 per cent soap Concentration, g. per 100 c.c.	Number of aphids	Per cent killed	Spreader, 1 per cent saponin Concentration, g. per 100 c.c.	Number of aphids	Per cent killed	Tolerance of plant g. per 100 c.c.
Nicotine........	0.01	287	99	0.1	868	99	>0.05
	.001	709	67	.01	1048	39	
αα—Dipyridyl.......	.5	925	93	—	—	—	< .5
	.1	813	60	—	—	—	
αβ—Dipyridyl.......	.5	350	100	.5	485	59	< .5
	.1	298	70	.1	548	38	
ββ—Dipyridyl.......	1.0	959	94	—	—	—	.1
βγ—Dipyridyl.......	.75	1046	97	—	—	—	.1
	.3	818	59	—	—	—	
γγ—Dipyridyl.......	.73	125	84	—	—	—	< .25
αα—Pyridylpiperidine	.5	494	97	—	—	—	—
	.1	364	74	—	—	—	
αβ—Pyridylpiperidine	.5	956	95	—	—	—	< .1
	.05	1148	87	—	—	—	
βα—Pyridylpiperidine (Neonicotine)	.05	860	100	.1	689	99	> .5
	.005	377	95	.02	849	56	
ββ—Pyridylpiperidine. (Nicotidine)	.5	248	96	.5	345	94	> .5
	.05	320	48	.1	304	44	
γγ—Pyridylpiperidine (Isonicotine)	2.1	300	99	—	—	—	< .29
	1.05	437	87	—	—	—	
αα—Dipiperidyl.....	.66	239	97	.5	245	60	.5
	.1	185	54	.1	251	32	
αβ—Dipiperidyl dihydrochloride....	.1	482	45	.5	506	12	> .5
ββ—Dipiperidyl.....	.35	398	91	—	—	—	< .1
	.1	433	60	—	—	—	
βγ—Dipiperidyl......	.1	254	99	—	—	—	> .1
	.01	366	83	—	—	—	
γγ—Dipiperidyl.....	2.1	797	69	—	—	—	1.0
ββ—Dipyridyldicarboxylic acid...	Sat. soln. (less than 1.0)	783	39	—	—	—	>Sat. soln.
αβ—Dipyridylmonocarboxylic acid hydrochloride.	.2	285	89	.2	406	34	> .2
αβ—Dipyridyldimethyliodide.....	—	—	—	.5	473	34	>0.5

TABLE—*Continued*

γγ—Dipyridyldimethyliodide.....	—	—	—	.5	423	39	> .5
γγ—Dipyridyldibenzylbromide....	—	—	—	.5	300*	<10*	> .5
Mono-N-methyl-αβ—pyridylpiperidine.......	—	—	—	.5	353	84	.5
Methylneonicotine	—	—	—	.1	1024	90	> .5
	—	—	—	.02	1166	43	
Methyl nicotinate	1.0	466	49	—	—	—	<3.0
Ethyl nicotinate	1.0	391	32	—	—	—	>1.0
α—Aminopyridine ..	2.0	484	95	—	—	—	2.0
β—Aminopyridine ..	1.1	481	84	—	—	—	—
Tetrahydro-α-aminopyridine dihydrochloride	1.2	218	94	—	—	—	.6
β—Bromopyridine..	5.0	490	88	—	—	—	<5.0
Piperidine oxide..	1.2	775	73	—	—	—	.6
Phenanthroline (Reduced)	—	—	—	.41	297	34	> .41

*Estimated

The pyridyl piperidines are particularly interesting to compare with nicotine. The latter compound differs from them in chemical structure in that it contains a saturated five-membered ring (pyrrolidine) in place of a saturated six-membered ring (piperidine). The most toxic of the pyridyl piperidines is the βα isomer, which has been called neonicotine, corresponding structurally with nicotine in which the unsaturated and saturated rings are also attached in the βα position. Most remarkable is the fact that neonicotine (βα-pyridyl piperidine) has practically the same toxicity as nicotine. It is of much interest to note further that the αβ isomer, although being very much less toxic than neonicotine, is more toxic than the other compounds of the series that have been investigated. In each series, then, the compounds with the αβ and βα groupings lead in toxicity over the compounds with the rings located in other positions.

LITERATURE CITED

1. RICHARDSON, C. H., and SMITH, C. R. Toxicity of dipyridyls and certain other organic compounds as contact insecticides. Jour. Agr. Res. 33: 597–609. 1926.
2. SMITH, C. R. Dipyridyls from pyridine. Jour. Amer. Chem. Soc. 46: 414–419. 1924.
3. ——— Dipiperidyls. Jour. Amer. Chem. Soc. 50: 1936–1938. 1928.
4. RICHARDSON, C. H., and SMITH, C. R. Studies on contact insecticides. U. S. Dept. Agr. Bul. 1160, 15 p. 1923.
5. RICHARDSON, C. H., and SHEPARD, H. H. The insecticidal action of some derivatives of pyridine and pyrrolidine and of some aliphatic amines. Journ. Agr. Res. 40: 1007–1015. 1930.

ROTENONE AS A CONTACT INSECTICIDE

By W. M. Davidson, *Associate Entomologist, Insecticide Control, Food and Drug Administration, Silver Spring, Maryland*

Abstract

Several different types of insects were tested with rotenone in an aqueous suspension and in dust form, the carrier being diatomaceous earth intimately mixed with precipitated rotenone. The aqueous suspensions were highly toxic to aphids, thrips, white fly larvae, leaf hoppers, larvae of beetles, tent caterpillars and culicine mosquitoes. Adult beetles required a much higher concentration. Poor results were obtained against squash bugs, red spiders and mealy bugs; this might have been remedied by the addition of a penetrating and sticking agent, as there is good evidence that the active ingredients of derris are toxic to these insects under optimum conditions of application.

The dusts were effective against chicken lice, roaches and cabbage worms, but results against soft bodied sucking insects were not so good.

For many years it has been known that the extracts from the roots of some of the tropical leguminous plants formerly embraced in the genus Derris, but now classed as the genus Deguelia, have high insecticidal value. The literature on this subject is extensive and a recent bibliography[1] lists 334 papers. Of these, 56 report actual tests with Derris extracts or commercial derris products. There are 36 papers giving results of tests against soft-bodied insects, including aphids, thrips, leaf-hoppers, caterpillars, and insect eggs. Nineteen papers report tests against insect pests of animals (warbles, lice, fleas, flies). Six papers report tests against mosquito larvae and four deal with soil insects (root maggots, leather jackets). A few insects of other types are mentioned, but the great majority of the work concerned the types listed above.

These published data are consistent in the main but there are a few inconsistencies. Recent chemical research into the constituents of derris has brought to light facts that may explain these inconsistencies. It has been ascertained that there are four major toxic constituents which vary widely in actual percentage and also in the proportions one to another,—no two samples of roots showing exactly the same proportions and amounts. Of these four toxic constituents, rotenone is the most important. Samples of derris root have been found to contain as much as 6 per cent by weight of this compound, but a few samples have contained none. Rotenone also occurs in "cube" roots (*Lonchocarpus nicou*) and in timbo, haiari, and other members of the genus Lonchocarpus.

[1]A Bibliography of Derris (Deguelia) species used as Insecticides (1747–1929). R. C. Roark, Insecticide Division, Bureau of Chemistry and Soils.

This paper reports tests to determine the value of rotenone as a contact insecticide against many species of insects. A later paper will contain data on the other three constituents.

EXPERIMENTAL. In the experimental work reported in this paper the rotenone used was of the highest purity, recrystallized from alcohol, and melted sharply at 163° C. It was obtained from Dr. F. B. LaForge of the Insecticide Division, Bureau of Chemistry and Soils. Tests were made with rotenone applied in two ways: (1) as a spray; (2) as a dust.

Rotenone is quite insoluble in water. Since it is easily affected by aqueous alkalies, it was thought best not to attempt to emulsify it in water with the aid of soap. Consequently the rotenone was dispersed in water, in all the tests reported in this paper, by dissolving it in acetone at the rate of about 4 grams per 100 cc. of acetone and adding this solution to water to form the dilution desired. Jones and Smith (J. Am. Chem. Soc. 52:2554, 1930) show that rotenone has a higher solubility in acetone than in any of the other water-miscible solvents which they tried, 100 cc. of acetone at 20° C., dissolving 6.6 grams of rotenone. The suspension of rotenone obtained by adding the acetone-rotenone solution to water was applied immediately to the insects. Furthermore, the concentrated solution of rotenone in acetone was freshly prepared before all tests. (In work to be reported by the author and Jones, it has been found that rotenone decomposes rather rapidly on standing in a number of organic solvents.) The water used in all the spraying tests reported in this paper was tested by C. G. Donovan, Assistant Chemist, Food and Drug Administration and found to contain a total of 3 grains solids per gallon. The pH was 7.1. The results of the spraying tests are shown in Table 1.

DISCUSSION OF TABLE 1. The physical nature of the diluted sprays, lacking a sticking or penetrating constituent, tended to cause them to run off such glabrous foliage as that of cabbage and nasturtium. Under these conditions of negligible adhesiveness and penetration, the great toxicity of rotenone stands out in high relief.

Three common greenhouse-inhabiting aphids were controlled at concentrations of 1:100,000 and 1:200,000. Field tests on three species of fruit tree aphids indicated that control was obtained at 1:40,000 and 1:60,000. Eggs of the pine woolly chermes (*Adelges*) were not killed at 1:20,000; untabulated tests with solutions of rotenone in pyridin dispersed in water showed that the nymphs are controllable at this concentration.

TABLE 1. CONTACT INSECTICIDAL ACTION OF ROTENONE ON VARIOUS INSECTS WHEN APPLIED AS A SUSPENSION IN WATER

(a) *Tests in a Greenhouse*

Insect Species, stage, and host plant	Concentration Gram: cc	Net Mortality Per cent
APHIIDAE		
Aphis rumicis L. active, on nasturtium	1:100,000	99.5
	1:200,000	100.0
	1:300,000	97.0
Brevicorne brassicae Koch, active, on cabbage	1:100,000	100.0
	1:200,000	97.4
Myzus persicae, Sulz., active, on cabbage	1:100,000	98.2
	1:200,000	94.3
COCCIDAE		
Pseudococcus citri Risso, active, on coleus	1:250	25.0
ALEYRODIDAE		
Trialeyrodes vapo1ariovum	1:2,000	99.1
Westwood[1] ova, on bean, etc	1:20,000	82.0
	1:100,000	9.6
Trialeyrodes vaporariovum Westwood, larvae, on bean, etc	1:30,000	94.9
	1:60,000	88.8
	1:100,000	94.7
Trialeyrodes vaporariovum Westwood, pupae, on bean, etc	1:250	0.0
THYSANOPTERA		
Thrips tabaci Lind., adults and larvae, on bean, etc	1:20,000	94.2
	1:30,000	69.3
	1:100,000	0.0
BLATTIDAE		
Blattella germanica L., active, in a wire cage	[2]1:250	0.0
	1:2,000	10.0
	1:10,000	10.0
LASIOCAMPIDAE		
Malacosoma americana Harris 3rd stage larvae, on plum and apple	1:100,000	47.0
Malacosoma americana Harris 1st and 2nd stage larvae, on plum and apple	1:30,000	100.0
TETRANYCHIDAE		
Tetranychus telarius L., active, on bean	1:90	78.6
	1:1,000	64.5
	1:2,000	60.7
	1:20,000	18.5
(b) *Tests in the Field*		
APHIIDAE		
Anuraphis roseus Baker, active, on apple	1:40,000	96.3
	1:60,000	90.2

[1]The mortality recorded pertained to the hatching larvae; eggs were not prevented from hatching, but the young larvae died. Larvae hatching from eggs deposited on the plant *after* spraying developed normally.
[2]Dipped 30 secs.

TABLE 1.—*Continued*

Aphis persicae-niger Smith, active, on peach	1:40,000	98.3
Aphis pomi De Geer, active, on apple	1:60,000	99.0
PHYLLOXERIDAE		
Adelges, ova, on pine	1:20,000	0.0
CICADELLIDAE		
Typhlocyba comes Say, nymphs, on grape	1:100,000	100.0
COREIDAE		
Anasa tristis De Geer	1:250	10.0
hibernating adults and nymphs, on squash	1:500	5.0
THYSANOPTERA		
Thrips sp., larvae, on *Plantago lanceolata*	1:10,000	100.0
	1:20,000	39.0
CHRYSOMELIDAE		
Diabrotica 12-punctata Oliv., adults, on potato	1:20,000	0.0
Doryphora 10-lineata Say., adults, on potato	1:2,000	60.0
	1:5,000	12.0
	1:10,000	0.0
Doryphora 10-lineata Say., ova, on potato	1:30,000	100.0
Doryphora 10-lineata Say., small larvae, on potato	1:30,000	95.0
Doryphora 10-lineata Say., large larvae, on potato	1:10,000	96.5
	1:30,000	92.9
COCCINELLIDAE		
Epilachna corrupta Muls., adults,[3] on bean	1:5,000	100.0
	1:10,000	85.0
	1:20,000	0.0
Epilachna corrupta Muls., small larvae, on bean	1:60,000	93.3
SCARABAEIDAE		
Popilia japonica Newman[4]		
adults, on smartweed (*Polygonum*)	1:1,000	100
foliage, in screen cages	1:5,000	97.3
	1:7,500	88.8
	1:10,000	85.8
	1:15,000	86.1
	1:20,000	60.9
CULICIDAE		
Culicine mosquito	1:1,150,000	98–99[5]
larvae in tubs	1:2,300,000	95[6]

[3]Overwintered beetles: others of the fall brood treated in October were much more resistant; less than 50 per cent. were killed at 1:500 and 1:250; all were killed at 1:125.

[4]These tests were made by L. J. Bottimer, Food & Drug Administration, Haddon Heights, N. J., in July 1930.

[5]These larvae were dead within 5 days. The eggs present hatched and the resultant larvae died within 2 days.

[6]Ninety-five per cent of the larvae were dead in 6 days but the remainder transformed into pupae. The eggs present hatched and 20% of the resultant larvae survived. Larvae and eggs in untreated tubs showed no abnormal mortality.

Mealy bugs (*Pseudococcus*) and red spiders (*Tetranychus*) were very resistant to the rotenone suspension.

Nymphs of the grape leaf-hopper were killed at 1:100,000.

A concentration of 1:20,000 was hardly sufficient to control the onion thrips under greenhouse conditions, and was of little value in the field against another species of thrips. A field test against adult *Frankliniella* infesting daisy flowers was made with a solution of rotenone in pyridin; a concentration of 1:16,000 killed 99 per cent and 1:20,000 killed 93.5 per cent. It would appear that effective concentration against thrips lies in the vicinity of 1:16,000 rotenone.

All stages of the larvae of the greenhouse white fly (*Trialeyrodes vaporariorum*) were controlled by a concentration of 1:30,000. The first stage larvae succumbed to a much greater dilution. The eggs were less easily killed; sprayed eggs hatched but most of the hatching larvae died without freeing themselves of the shell, and others freed themselves only to die later without growing. The pupae were very resistant.

Squash bugs (*Anasa tristis*), including the nymphs in the later stages, and the common roach (*Blatella germanica*) proved very resistant to the rotenone suspension. Small tent caterpillars were easily killed. Tests with the pyridin solution indicated that larvae in the penultimate instar of the imported cabbage butterfly (*Pontia rapae* L.) were killed at a concentration of rotenone 1:75,000. Similar tests against the earliest nymphal state of squash bugs resulted in 84 per cent mortality at a rotenone concentration of 1:5,000 and in a 61 per cent mortality at 1:10,000. This type of insect is not readily controlled by aqueous suspensions, requiring a carrier of penetrating ability in the spray.

Adult potato beetles (*Doryphora 10-lineata*) were highly resistant, the eggs and larvae susceptible. A concentration of 1:5,000 controlled Japanese beetles tested in cages of the type commonly used by the Japanese Beetle Laboratory, Bureau of Entomology.

No foliage injury, even in the case of such susceptible plants as peach, string bean and Japanese plum, resulted in any instance.

Two dusts containing respectively one per cent and two per cent rotenone were prepared by the Insecticide Division of the Bureau of Chemistry and Soils. The rotenone used was prepared by precipitation from a solution in acetone by the addition of water, in order to obtain it in a very finely divided form, and mixed intimately with diatomaceous earth. Results of these tests are shown in Table 2. In the tests against phytophagous insects, the infested plants were dry at the time of applying the dusts.

TABLE 2. CONTACT INSECTICIDAL ACTION OF ROTENONE ON VARIOUS INSECTS WHEN APPLIED AS A DUST DILUTED WITH DIATOMACEOUS EARTH

Species of insect, stage and host plant	Net Mortality 1% rotenone Per cent	Net Mortality 2% rotenone Per cent
(a) *Tests in a Greenhouse*		
APHIIDAE		
Aphis rumicis L., active, on nasturtium	—	100.0
Myzus persicae Sulz., active, on cabbage	—	76.6
Aphis gossypii Glover, active, on celery	—	68.9
COCCIDAE		
Pseudococcus citri Risso, active, on coleus	—	0
THYSANOPTERA		
Thrips tabaci Lind., larvae, on bean	—	65.5
TETRANYCHIDAE		
Tetranychus telarius L., active, on bean	—	0
(b) *Tests in the Field*		
APHIIDAE		
Aphis pomi, active, on apple	77.2	—
Illinoia liriodendri Monell, active, on tulip tree	—	88.4
COREIDAE		
Anasa tristis, nymphs, on squash	<50.0	<50.0
PIERIDAE		
Pontia rapae L., large larvae, on cabbage	100	100.0
COCCINELLIDAE		
Epilachna corrupta Muls., half-grown larvae, on bean	100	—
(c) *Tests in a Cage*		
BLATTIDAE		
Blattella germanica L., active	99	100
(d) *Tests in a Coop*		
MALLOPHAGA		
Menopon pallidum Nitzch. and *M. stramineum* Nitzch., on chickens	100	100

The dusts were not very effective against sucking insects. The cabbage worms and bean beetle larvae died almost instantaneously and were evidently killed by contact. The roach tests were made in small frame cages 9½"x 7½"x 2¼" inside measurements. When the dust was applied directly on the insects all died within 24 hours. The rotenone was partially effective upon roaches placed in the dusted cages 21 hours after application to the cages, indicating that some of the roaches were poisoned by ingesting particles of rotenone. Examination of dusted fowls showed that all the body lice, and the shaft lice dusted with the two per cent dust, had dropped off within 48 hours. The one per cent dust did not entirely free the fowls of shaft lice within 2 days, but a

second examination, 3 days after the first, failed to show any living shaft lice. This test did not disclose whether the rotenone acted as a contact, a repellent, or as an internal poison.

SUMMARY. A series of preliminary tests against insects representative of different types, and amenable to control by contact insecticides, indicates that rotenone, a product extracted from the root of derris, has a high degree of toxicity. The results obtained from the use of suspensions and dusts tend to confirm those reported by other investigators for derris extract. In suspensions, rotenone proved valuable against such soft-bodied insects as aphids, thrips, leaf-hoppers, caterpillars, beetle larvae, and the immature stages of culicine mosquitoes. When freshly dispersed in water by dilution of an acetone solution, rotenone is effective against *Aphis rumicis* at a concentration about one-fifteenth of that at which nicotine is effective. Aqueous suspensions were not effective against red spiders, mealy bugs, and squash bugs. This inefficiency against squash bugs, red spiders and possibly mealy-bugs, appears due more to lack of penetrating power in the suspensions used than to absence of intrinsic toxicity, and would probably be remedied by incorporating rotenone in a penetrating carrier, such as an oil. Roaches, potato beetles and cucumber beetles resisted the suspension sprays.

Dusts containing one and two per cent rotenone were only moderately effective against soft-bodied sucking insects. They controlled cabbage worms, young Mexican bean beetle larvae, roaches, and both body and shaft lice on chickens; the roaches, perhaps, more through internal poison than contact action.

THE ECONOMICS OF PYRETHRUM[1]

By JOHN GLASSFORD, *Chief Chemist, McCormick & Co., Inc., Baltimore, Md.*

ABSTRACT

Japan now produces 6/7 of the world's pyrethrum flowers. The imports into the United States have increased from 3,000,000 lbs. in 1923 to 9,000,000 lbs. in 1929. Average consular invoice values decreased from 47c a lb. in 1923 to 18c a lb. in 1929. A 1% lubricating oil spray costs about 0.3c per gallon; a lead arsenate spray, 1.2c.; a lime sulphur spray, 1.75c.; a nicotine spray containing 0.04 per cent of alkaloid, 1.84c; and a pyrethrum spray, containing 0.04 per cent of oleoresin of pyrethrum and activated with soap, costs 2.2c per gallon.

The cost of waging warfare against his insect enemies is an item of growing importance to the farmer. Arsenic, sulphur, lime and oil,

[1]Presented before the Division of Agricultural and Food Chemistry at the Atlanta meeting of the American Chemical Society in 1930.

which for so many years have been his principal weapons of attack or defense, must now often be replaced by insecticides which are less poisonous to man, more effective or both. Among these newer insecticides are two of vegetable origin which have proved to be very valuable weapons and one which promises to be. These are nicotine, the pyrethrins, and rotenone. Of these only the pyrethrins and rotenone are strictly non-poisonous, but nicotine, being volatile does not leave a poisonous residue. The cost of these vegetable insecticides, however, is greater than that of the mineral poisons so long used and is sometimes prohibitive. This has been particularly true of the pyrethrins. Recent investigations, however, have shown that, used with the proper materials to spread, or, as it is sometimes said, "activate," a spray of remarkably increased toxicity is obtained and the cost of spraying correspondingly reduced.

Pyrethrum, containing the pyrethrins, has been known for many years, but it has, until recently, been used only against household pests, its cost being the principal obstacle to its field use. Pyrethrum is not now grown commercially in this country although it was formerly so grown in California and probably will be again. Twenty-five or thirty years ago, there were two pyrethrums on the market; the Persian and the Dalmatian. The Persian, which was red, was *Pyrethrum roseum;* the Dalmatian, which is yellow, is *Pyrethrum cinerariaefolium.* The Persian flowers have disappeared entirely from the market and the cultivation of the yellow variety has been taken up by the Japanese who now supply six-sevenths of the world's production. The imports of the United States have increased from about 3,000,000 pounds in 1923 to 9,000,000 pounds in 1929. The maximum world production was in 1928 when the total reached almost 19,500,000 pounds, of which Japan produced 17,750,000 and consumed 5,000,000. The United States uses 70 per cent of the world's production. Average consular invoice values decreased from 47 cents a pound in 1928 to 18 cents a pound in 1929.

Pyrethrum was first used as a field spray against the Cochylis and Eudemis infesting the grape vines of France. It was used in the form of an emulsion with 15 pounds of pyrethrum per hundred gallons. Such a spray in 1923 would have cost 7½ cents per gallon, and even with pyrethrum at present prices it would be prohibitive for most purposes. A 1 per cent lubricating oil spray costs about 0.3 cents per gallon. A lead arsenate, spray suitable for use against the Japanese Beetle in corn, costs 1.2 cents per gallon; a lime sulphur spray, 1.75 cents per gallon and a nicotine spray containing 0.04 per cent of the alkaloid costs 1.84 cent per gallon. A pyrethrum spray containing 0.04 per cent

of oleoresin and activated with soap, costs 2.2 cents per gallon which makes it the highest priced of any of the sprays in common use.

In spite of their high price, however, pyrethrum sprays are indispensable for some purposes, against the blunt nosed leaf hopper infesting cranberry bogs and transmitting the virus of the false blossom disease for instance. And against the celery leaf tier there is no substitute, only pyrethrum dust may be used. In other cases as that of the Mexican bean beetle, only pyrethrum sprays can be effectively used when the crop is approaching maturity and the magnesium arsenate effective in the earlier stages can no longer be used on account of its poisonous nature. No doubt, the efficiency and harmlessness of pyrethrum would lead to its very extensive use if the obstacle of its high cost could be in part overcome. A number of scientists are working to this end. Staudinger and Harder, the former of whom, with Ruzicka, first isolated the pyrethrins, are again pioneers in the development of a method for the chemical assay of pyrethrum preliminary to the development by selection and propagation of a strain of *Pyrethrum cinerariaefolium* of higher toxic value than that now grown. Gnadinger and Corl find that pyrethrum flowers which have fully opened, contain 18 to 61 per cent more pyrethrin than the closed flowers which for so many years have been thought to be superior. As the average weight of the open flowers is about double that of the closed, Gnadinger and Corl suggest trebling or quadrupling the weight of the toxic principles obtained per acre of pyrethrum cultivated by the simple expedient of allowing the flowers to reach maturity. Sievers of the Bureau of Plant Industry proposes the concentration of pyrethrum by threshing to separate the achenes which contain 90 per cent of the pyrethrin. This concentration will save both freight and cost of grinding which is now about 3 cents a pound, for the impalpable powder. A saving in the cost of extraction would also be effected.

The price of pyrethrum flowers at Kobe, Japan, according to a report of the Department of Commerce was 15¾ cents per pound on January 25th, last, with prospects that the price would be forced down to 14½ cents per pound, cost and freight to New York, for new crop flowers. While exact figures on cost of production are not available, it would seem that a price of at least 15 cents per pound is necessary to insure continued cultivation. If crops can be doubled by being allowed to mature more fully before harvesting, it is possible that cultivation will pay at 12 cents per pound and taking into consideration the increased activity of the larger crop, it may be possible that a finished pyrethrum spray may be reduced to one-half its present price per gallon, or about

1.5 cents which is comparable with the lead arsenate spray at 1.2 cent per gallon. Similarly with pyrethrum dusts, while the price of pure pyrethrum powder is prohibitive its extract carried on the surface of dust particles is increased in efficiency many fold and the cost of dusting correspondingly reduced. Used in this way the pyrethrins are efficient for some purposes at a dilution of 1 to 133,000.

The two rotenone-containing insecticides, Derris from the East Indies and Cube from South America, also promise to be useful vegetable insecticides. Derris contains 0.5 to 5.5 per cent of rotenone, and cube up to 7 per cent with an average of about 4 per cent. Rotenone is said to be on the average, about equal in toxicity to pyrethrin. Commercial prices on these insecticides are not yet stabilized, but if they can be obtained as cheaply as it is hoped, finished sprays may possibly be made for from ¾ to 1 cent per gallon.

The Bureau of Chemistry and Soils is endeavoring to synthesize rotenone. The successful accomplishment of this task may lead to still lower production cost and give the farmer one of the most powerful weapons that ever has been devised for use against the arch enemies of all mankind in what Dr. L. O. Howard has called the greatest war of all times.

THE RELATIVE VALUE AS CONTACT INSECTICIDES OF SOME CONSTITUENTS OF DERRIS*

By W. M. DAVIDSON, *Associate Entomologist, Insecticide Control, Food and Drug Administration, Silver Spring, Maryland*

ABSTRACT

Aqueous suspensions of the four principal constituents of Derris root, i.e., rotenone, deguelin, tephrosin and toxicarol, were sprayed upon aphids, thrips, white fly larvae and red spider mites living on potted plants in a greenhouse. Their relative contact insecticidal value was in the order given, with rotenone the most potent; with reference to *Aphis rumicis*, they stood in the approximate ratio of 400:40:10:1. Rotenone and deguelin are both more toxic than nicotine to *A. rumicis*.

Clark (Science 71:306, 1930; J. Am. Chem. Soc. 52:2461, 1930) has isolated and described three constituents of Derris root other than rotenone. These are deguelin,[1] pale green crystals, $C_{23}H_{22}O_6$, melting

*The data in this paper were presented in part in a paper entitled "Tests of the Insecticidal Value of Derris Constituents" read at the Insecticide Symposium of the Division of Agricultural and Food Chemistry of the 79th Meeting of the American Chemical Society, Atlanta, April 8, 1930.

[1]Deguelin is the name recently given by Clark to the $C_{23}H_{22}O_6$ compound described by him in the articles cited. Private communication from E. P. Clark, Insecticide Division, Bureau of Chemistry and Soils, Washington, D. C.

point 171°; tephrosin, colorless crystals, $C_{23}H_{22}O_7$, melting point 198°; and toxicarol, yellow crystals, $C_{23}H_{22}O_7$, melting point 219°.

Deguelin and toxicarol have been shown by Gersdorff[2] to be highly toxic to goldfish. For example, at a dilution of 1 part in 20,000,000 parts water at 27° C. goldfish weighing approximately 2 grams were killed by rotenone in 2½ hours, by deguelin in 3 hours, and by toxicarol in 5 hours. At this concentration, tephrosin did not kill goldfish in 24 hours but at higher concentrations it approaches the toxicity of toxicarol. Tattersfield, Gimingham and Morris (Ann. Appl. Biol. 12:61–76. 1925) have published the results of insecticidal tests with tephrosin but no work has been reported by entomologists with toxicarol or deguelin.

Experimental. The pure compounds, deguelin, tephrosin and toxicarol were obtained from E. P. Clark, of the Insecticide Division of the Bureau of Chemistry and Soils. The crystals of rotenone, deguelin and tephrosin were dissolved in acetone and those of toxicarol were dissolved in ethyl alcohol to which a few drops of 10 per cent sodium hydroxide solution had been added. When their solutions were added to water these compounds were precipitated out in the form of finely dispersed suspensions. These suspensions were immediately sprayed upon the insects. No soap, saponin, or other wetting or spreading agent, was added in any test. All tests were conducted in a greenhouse.

The results are shown in Table 1.

Discussion. These comparative data, incomplete as they are, indicate nevertheless that, as a contact spray, rotenone is considerably the most toxic of the four compounds when prepared for application as indicated. Deguelin appears to hold a position intermediate in toxic value between rotenone on the one hand and tephrosin and toxicarol on the other. The relative toxicity of these compounds to Aphis rumicis is approximately as follows:

Rotenone	〉	deguelin	〉	tephrosin	〉	toxicarol
400		40		10		1

Comparing these results with those reported by Richardson and Smith (U. S. D. A. Dept. Bul. 1160, 1923) for nicotine, it is shown that rotenone and deguelin are more toxic to *Aphis rumicis* than is nicotine.

The gradation in toxicity of these four substances forms a clue to the variations in insecticidal potency that have been observed in samples of Derris root. One would expect a sample low in rotenone and high in toxicarol to yield results inferior to those secured from a sample of

[2]Private communication from W. A. Gersdorff, Insecticide Division, Bureau of Chemistry and Soils, Washington, D. C.

Table 1. Tests With Four Constituents of Derris Root as Contact Insecticides

Suspensions in Water Sprayed

		Net Mortality			
Insect and Host Plant	Concentration Gram. cc.	Rotenone Per cent	Deguelin Per cent	Tephrosin Per cent	Toxicarol Per cent
Aphis rumicis L.	1 : 500	——	——	——	94.5
on nasturtium	1 : 5,000	——	——	100.00	——
	1 : 10,000	——	100.0	——	0.0
	1 : 20,000	——	100.0	65.0	0.0
	1 : 30,000	——	99.0	——	——
	1 : 200,000	100.0	——	——	——
Brev. brassicae Koch	1 : 500	——	——	——	0.0
on cabbage	1 : 5,000	——	94.0	0.0	0.0
	1 : 10,000	——	95.1	——	——
	1 : 20,000	——	——	0.0	——
	1 : 30,000	——	66.4	——	——
	1 : 100,000	100.0	——	——	——
Trialeyrodes vaporariorum	1 : 500	——	——	——	25.0
Westwood, larvae, on	1 : 2,000	——	19.7	——	——
bean, etc.	1 : 5,000	——	25.0	0.0	5.0±
	1 : 20,000	——	34.0	14.0	5.0±
	1 : 30,000	94.9	23.0	——	——
Thrips tabaci Lind.	1 : 250	——	——	——	12.0
on bean, etc	1 : 2,000	——	50.0+	——	——
	1 : 10,000	——	50.0+	——	0.0
	1 : 20,000	94.2	——	——	——
Tetranychus telarius L.	1 : 2,000	60.7	10.0±	——	18.0
on bean, etc.	1 : 5,000	——	10.0±	10.0±	12.0
	1 : 20,000	18.5	——	10.0±	10.0

reverse composition. From our present knowledge of the chemistry of derris root, and of the value of its constituents as contact insecticides, it would appear that the rotenone content is the most important criterion for measuring the value of any sample of root. Unless occurring in unusually high content, the three other constituents would not substantially affect the insecticidal quality of the extract from such a sample.

ROCKY MOUNTAIN CONFERENCE OF ENTOMOLOGISTS

The seventh annual Rocky Mountain Conference of Entomologists was held at Pingree Park, Colorado, August 18 to 23 inclusive. Unprecedented rains in some localities just before the Conference discouraged some from making the trip by automobile, but the weather cleared and was ideal during the entire week.

A total of 52 were in attendance. The following are those that were directly interested in Entomology:

C. L. Marlatt	Washington, D. C.
C. P. Gillette	Fort Collins, Colorado
Bernard Liston	Wichita, Kansas
A. W. Lindquist	Manhattan, Kansas
Carl A. Bjurman	Fort Collins, Colorado
John C. Hamlin	Salt Lake City, Utah
W. A. Shands	Grand Junction, Colorado
Esther Travis	Fort Collins, Colorado
W. H. Larrimer	Washington, D. C.
C. J. Drake	Ames, Iowa
Miriam A. Palmer	Fort Collins, Colorado
Geo. I. Reeves	Salt Lake City, Utah
John L. Hoerner	Fort Collins, Colorado
Sam. C. McCampbell	Fort Collins, Colorado
Tom A. Brindley	Ames, Iowa
Rowan Potter	Wichita, Kansas
D. G. Rice	Grand Junction, Colorado
J. H. Newton	Poania, Colorado
I. M. Hawley	Salt Lake City, Utah
A. P. Sturtevant	Laramie, Wyoming
Leonard Haseman	Columbia, Mo.
Wilber G. Fish	Ithaca, New York
Leslie B. Daniels	Fort Collins, Colorado
Geo. M. List	Fort Collins, Colorado
F. T. Cowan	Fort Collins, Colorado
C. R. Jones	Fort Collins, Colorado
R. G. Richmond	Fort Collins, Colorado
Bernard Travis	Fort Collins, Colorado
Elwood H. Sheppard	Reading, Minn.
C. L. Corkins	Laramie, Wyoming

A total of ten sessions were held during the week for discussion and papers. These meetings were all very informal which led to a very free discussion of all topics and the subjects listed below give only an indication of the various ones that came up for consideration.

Onion Insects of Iowa—C. J. Drake
Importance of Insect Physiology and Morphology—Leonard Haseman
The Rose Snout Beetle—J. L. Hoerner
The Potato Flea Beetle—L. B. Daniels
The Work of the United States Bureau of Entomology, and the Mediterranean Fruit Fly Situation—C. L. Marlatt
New or Outstanding Insects of the Year—L. Haseman, J. H. Newton, C. J. Drake, G. I. Reeves, A. W. Lindquist, B. Liston, R. Potter, W. A. Shands, F. T. Cowan, S. C. McCampbell, C. P. Gillette.
The Beet Leaf-hopper—W. A. Shands.
The Control Campaign Against the Mormon Cricket—F. T. Cowan

Symposium—Research in Entomology.
  Training for Research—C. P. Gillette
  Organization for Research—C. L. Marlatt
  Opportunities in Research—W. H. Larrimer
  What is Wrong in Entomological Research—The Youngsters
Generic and Specific Characters of Aphids—M. A. Palmer
Early Notes on Colorado Insects—C. P. Gillette
Alfalfa Weevil Population—J. C. Hamlin
Notes on the Alfalfa Weevil—I. M. Hawley
Food Habits of the Agricultural Ant—C. R. Jones
Red Clover Pollenization—R. G. Richmond
Temperature and Humidity Control Boxes—T. A. Brindley
Work of the Intermountain Bee Station—A. P. Sturtevant
Metabolism Studies of the Honey Bee—C. L. Corkins
Cherry Insects of Northern Colorado—Geo. M. List
Some External Parasites of the Rodent Family Sciuridae, in Colorado—S. C. McCampbell
Heat, Caramelization and Regranulations of Honey—R. G. Richmond

Insect collecting, fishing, horse-shoes, and miniature golf were the chief diversions. One entire day was given for the longer mountain trips and for those that collected and fished most earnestly. Mr. Bernard Liston won the miniature golf tournament for men and Mrs. Liston won it for the ladies. This offered probably the keenest competition of any of the sports. The regular golfers, especially Dr. C. L. Marlatt and Dr. C. J. Drake, were much chagrined to see the prize taken by a beginner.

Dr. C. J. Drake won the horse-shoe pitching contest but only after Dr. Leonard Haseman withdrew from the contest because mule shoes were not permitted.

Dr. W. H. Larrimer was the most persistent and successful fisherman and largely through his efforts the entire crowd was furnished mountain trout for three meals. As a matter of record it might be stated that his largest one was 15½ inches while the one caught by Dr. Marlatt in his initial attempt to cast a fly, was not over 12½ inches.

A more complete report of the meeting, which will give a short summary of each paper, will be mimeographed and sent to those that have attended the Conference in the past and any others that may request it.

The officers elected for 1931 were C. P. Gillette, Chairman; Geo. I. Reeves, Vice-Chairman; Geo. M. List, Secretary; C. R. Jones, Treasurer.

GEO. M. LIST, *Secretary*

Scientific Notes

Argentine Ant in Maryland. Ants collected on February 6, 1930, at the Clifton Park Greenhouses, Baltimore, Maryland, were identified by Dr. M. R. Smith, A. & M. College, Mississippi, as *Iridomyrmex humilis*. Since then the ant has been found in the Druid Hill Park and Carroll Park greenhouses, but an examination of commercial greenhouses has failed to reveal its presence in any of them.

ERNEST N. CORY, *State Entomologist, College Park, Maryland*

Clover weevils become injurious to beans. During the latter part of July our attention was called to three cases of serious injury to beans caused by the clover weevils, *Hypera meles* Fab. and *H. nigrirostris* Fab. These outbreaks were at Rush, Odessa, and near Trumansburg, N. Y. In each case the injury was most severe in the part of the field adjacent to a hay barn. It seems probable that the beetles were carried into the barn with clover hay and that on escaping from the building they were forced to feed on the beans. We have been unable to find a record of beans being a food plant of these weevils. The beetles ate holes in the pods, in the stems and petioles, causing the leaves to wilt down and die.

C. R. CROSBY and W. E. BLAUVELT. *Ithaca, New York*

Silkworms and Their Parasites in New Caledonia.—Dr. Jean Risbec, of Noumea, New Caledonia, writes me that a colonist living at Yaté, New Caledonia, recently undertook to introduce silkworms, with the idea of establishing a silk industry. To his surprise, they were severely attacked by Hymenopterous parasites which were already present in New Caledonia. Dr. Risbec sends me specimens of these. One is *Chalcis falsosa* Vachal, described from New Caledonia. There are two males and a female of a fine bright ferruginous *Lissopimpla*, with partly black abdomen. This is very different from *L. semipunctata* Kirby (*Notiopimpla priosnemidea* Vachal), recorded in 1907 from New Caledonia. It may be *L. pacifica* Morley, of which I lack the description. Another genus of Pimplines is represented by two males, which I cannot place without females.

T. D. A. COCKERELL, *Boulder, Colorado*

A Note on two Hymenopterous Parasites of *Diatraea saccharalis* Fab.—Specimens from Tucumán and Güemes, Argentina, some of which were collected as adults in sugarcane fields, some reared from cocoons found in corn, and one reared from a Diatraea larva collected in corn, were determined by Mr. R. A. Cushman as *Bassus stigmaterus* Cress. Four other specimens reared from cocoons found in Diatraea tunnels in corn at Moncada, Peru, were also determined as *B. stigmaterus*. Previously, this species has been reported only from Cuba. It does not appear to be very abundant either in the Argentine or in the sections of Peru visited.

Two adults reared from cocoons found in very small Diatraea tunnels in corn at Tucumán were determined by Mr. Cushman as *Apanteles xanthopus* Ashm. I believe this is the first time that this species has been reported as a parasite of *Diatraea saccharalis* Fabr.

H. A. JAYNES, *Bureau of Entomology, U. S. Dept. of Agriculture, Tucuman, Argentina*

***Dicymolomia julianis* Walk. Predatory upon Bagworm Eggs.**—*Dicymolomia julianis* Walk., a Pyralid moth, has been reared a number of times by the writer from egg masses of the bagworm, *Thryidopteryx ephemeraeformis* Haworth. The larvae were found feeding in egg masses which were all eaten by the time larval maturity was reached. Two larvae were discovered in dried pupal skins. They fed readily upon bagworm eggs, but failed to pupate, so positive identification was impossible. This would be more in keeping with the scavenger habits of *D. julianis*, as it ordinarily feeds in Typha heads. Possibly this may presage a change in food habits as it is unlikely that it is entirely a matter of chance that the larva of *D. julianis* is found in egg masses of the bagworm.

The only previous record in the literature is also from College Park, Maryland. In the Journal of Economic Entomology, Vol. 2, pages 236–237, 1909, A. B. Gahan states that he reared *D. julianis* from eggs of the bagworm. His observations were practically the same as those made by the writer. The authenticity of Gahan's observations has been questioned. It is therefore of interest to call this record to the attention of entomologists.

The specimens of *D. julianis* were determined by Mr. Carl Heinrich of the United States National Museum.

DONALD MCCREARY, *Department of Entomology, University of Maryland, College Park*

Nicotine in Paint for Woolly Aphis Control.—Due to the fact that woolly apple aphis predisposes callus tissue on pruning wounds and canker surgically treated, to perennial canker infection—*Gloeosporium perennans* Zeller and Childs, various painting treatments have been employed to control the insect. All paints that lift or crack as a result of the influence of the growing callus were found to be useless, in fact, paints that crack and lift offered protection to the aphids and the calluses treated often become more severely attacked due to the protection offered than is the case of untreated calluses. To exert a satisfactory influence on aphis control a paint must adhere closely to the growing callus and expand with the growth of the plant tissue. No paint applied in the spring has been found to meet, in all cases, this requirement though paints with a base as elastic as tanglefoot have been employed as well as a proprietary paint known as the Hood River tree paint.

Nicotine used in the form of Black Leaf 40 was found to greatly increase the efficiency of the applications which were made from paints employing tanglefoot and the Hood River tree paint—a rosin, fish oil-copper salts combination. The tanglefoot was diluted with both gasoline and carbon tetrachloride, used alone and together, to a point where it could be applied with a brush. The tree paint was diluted with gasoline. To these combinations the Black Leaf 40 was added in amounts of one part to four, one part to eight, and one part to sixteen in a number of tests. Complete control for the season resulted where the paints were diluted with one part of nicotine to four parts of the paints used. Control was satisfactory where the dilution of one to eight was employed and less effective with the one to sixteen dilution. Extensive infestation developed on the calluses where the paints were used without the addition of the Black Leaf. In limited tests nicotine has been recovered from paints at a period as long as nine months following the application. There is some evidence to the effect that the nicotine in the paint not only acts as a repellent to the aphis but as a contact poison to the young aphis as they seek out a location for establishment.

LEROY CHILDS

Two Leafhoppers of Apple and Prune in Southern Idaho and Eastern Oregon.—Leafhoppers are frequently very abundant in apple and prune orchards of southern Idaho and eastern Oregon. They feed on the under side of the leaves and a characteristic white flecking results from the feeding punctures. When the infestation is heavy the leaves become yellowish and injury to the tree results from the severe sapping of the leaves. Injury to the fruit consists of a stunted growth due to the reduced vitality of the tree, and of an unsightly spotting from the excrement of the leafhoppers.

Childs[1] has reported the rose leafhopper, *Empoa* (or *Typhlocyba*) *rosae* (Linn.) as a pest of apple in Oregon and the Pacific Northwest. Melander[2] has reported two species as common on apple in Washington: the apple leafhopper, *Empoasca mali* (LeBaron) and the rose leafhopper, *Empoa rosae* (Linn.). Edmundson[3] reported the apple leafhopper, *Empoasca mali* (LeBaron) as very common in Idaho.

Collections of leafhoppers were made during the summer of 1930 in numerous orchards of southern Idaho and eastern Oregon. Two species were found to be common on apple and one of these also common on prune. Some confusion has existed as to the identity of the two species occurring in this district. The white one has always been confused with *Typhlocyba rosae* (Linn.). Specimens were submitted to Dr. Dwight M. DeLong of Ohio State University, who determined them as *Empoasca maligna* (Walsh) and *Typhlocyba pomaria* (McA.).

Empoasca maligna (Walsh) is a light green leafhopper and was found to be common on apple at Parma, Fruitland, and Twin Falls in Idaho, and in the Malheur Valley of eastern Oregon. Single specimens were taken from cherry at Emmett, Idaho and from prune at Meridian, Idaho.

Typhlocyba pomaria (McA.) is a cream colored or whitish leafhopper found to be common on apple at Parma, Fruitland, and Twin Falls in Idaho, and in the Malheur Valley of eastern Oregon. This species was also common on prune at Parma and Meridian, Idaho, and in the Malheur Valley, Oregon.

The two species *Empoasca mali* (LeBaron) and *Typhlocyba rosae* (Linn.) did not occur in these collections from apple and prune.

ROWLAND W. HAEGELE, *Entomological Field Station, Idaho Agricultural Experiment Station, Parma, Idaho*

The Efficiency of the Air-Blast Type of Sprayer for Applying Insecticides. Since the appearance of air-blast sprayers on the market, entomologists and fruit growers have raised the question of the efficiency of these machines for applying insecticides to fruit trees. As a result of many requests for information on this subject, an experiment was conducted to determine the value of the air-blast type of sprayer as compared with the ordinary power spray outfit for applying dormant sprays to peach trees for the control of the San Jose scale.

Lubricating-oil emulsion (67.67 per cent oil) at the rate of 9 gallons of the concentrate to 191 gallons of water, and liquid lime sulphur (32° Baumé) at the rate of 25 gallons of the concentrate to 175 gallons of water were used for the experiment. A tank-load of each insecticide was applied with an air-blast sprayer and with the ordinary power spray outfit. The spraying was done on an unusually calm day. On

[1] Leroy Childs, Bul. 148, Ore. Agr. Exp. Sta. 1918.
[2] A. L. Melander, Ext. Cir. 9, State Col. of Wn.
[3] W. C. Edmundson, Bul. 87, Univ. Ida. Agr. Exp. Sta. 1916.

account of the favorable conditions under which these tests were conducted, the results with the air-blast sprayer perhaps represent the best that can be expected from that machine. All of the spraying was done by laborers experienced in spraying with this type of outfit and the ordinary power spray outfit. The average percentages of control of the San Jose scale from the two insecticides therefore indicate the results to be obtained by the average grower in spraying for that insect.

Twenty record trees were selected in each plat. Scale counts were made from each of these trees just before the sprays were applied, and then again from the same trees one month after spraying. The results of the experiment are as follows:

Plat No.	Insecticide used	Applied with	Average per cent of scale alive before spraying (Feb. 19, 1930)	Average per cent of scale alive one month after spraying (Mar. 22, 1930)	Average per cent of control of the San Jose scale
I	Lubricating-oil emulsion (9–191)	Air-blast sprayer	75.8±0.91	3.1±0.79	95.9±0.98
II	Lubricating-oil emulsion (9–191)	Power spray outfit	76.4± .75	4.1± .66	94.7± .85
III	Liquid lime sulphur (25–175)	Air-blast sprayer	73.9±1.14	35.2±1.39	51.9±2.06
IV	Liquid lime sulphur (25–175)	Power spray outfit	76.0± .75	26.1± .79	65.7± .91

OLIVER I. SNAPP and JAMES R. THOMSON,
U. S. Peach Insect Laboratory, Fort Valley, Georgia

***Dichomeris piperatus* Walsingham, a Pest of Alfalfa in Puerto Rico.**—Carbohydrates as food for cattle are easily raised in Puerto Rico, but practically all the proteins fed to dairy cattle as concentrates on the Island are imported. The Department of Agriculture of Puerto Rico has demonstrated that alfalfa hay of the best quality can be produced at its Sub-Station in Isabela. According to Mr. L. A. Serrano, Director of this Sub-Station, a crop can be harvested every thirty-three days after the plantation is one year old and this yields some eight tons of dry hay per acre per year, which is as good or better than the production in many temperate climates. There are no data, however, as to the duration of alfalfa plantations under our tropical conditions.

Mr. Serrano does not believe that alfalfa could be grown as successfully in the more humid parts of the Island where heavier soils and rainfall would not allow it to produce the long tap root which is essential for its proper development and which the irrigated loose soils of the Isabela region make possible. But still, alfalfa hay could be produced in this region for the rest of the Island.

So far two important insect pests have attacked the alfalfa at Isabela. One is a Geometrid which appears during the winter months. The other becomes very abundant in the spring and is a Gelechiid, *Dichomeris piperatus* Walsingham, determined for us by Dr. William T. M. Forbes at present studying the Lepidoptera of the Island for the Scientific Survey of Porto Rico conducted by the New York Academy of Science. Dr. Forbes has given us the following notes and description:

The adult of *D. piperatus* is a small moth about one-fourth of an inch long, buff in color with three pairs of black dots on the wings. The front pair is not so well marked as the other two. The palpi have a large triangular second joint and a very

slender third, as in the Palmer worm and the diamond back moths. *D. piperatus* was described from St. Vincent and later bred from a legume in Saint Thomas, West Indies. The native host plant on which the insect breeds in Puerto Rico has not been determined yet. Adults have been collected in Puerto Rico at Santurce, Mar. 25–30 by Hoffmann, at Coamo Springs, Apr. 6–30, at Cataño, Apr. 21–30 and at Puerto Real (Vieques Island) April 29–30 by Drs. W. T. M. Forbes and M. D. Leonard.

The following are the references on *D. piperatus:* Proc. Zool. Soc. 1891, p. 526; and 1897, p. 86 for the larva (Gudmann).

FRANCISCO SEÍN, JR., *Ass't. Entomologist, Ins. Expt. Station, Rio Piedras, P. R.*

Evaluation of *Trichogramma* Liberations.—The liberations of *Trichogramma* against insect pests have not yet been definitely proven to be of practical value. In order that several factors that should be considered may be brought to the attention of those who for the first time undertake to make use of this parasite, the writer submits the following observation:

The effectiveness of liberations made for the purpose of hastening the building up of the parasite population is more difficult to determine than that of liberations made to effect immediate reduction in the host population. The first or *accretive* method is of necessity employed against pests of field crops; the second or *inundative* method against greenhouse and orchard pests.

For the employment of the accretive method it is necessary that the host deposit eggs continuously throughout the first half of the season so that eggs are always present in sufficient numbers at a time when a rapid increase in the number of parasites is most effective. Liberations should be made each season only when such conditions first occur. If such conditions are satisfactorily produced at various points by the use of attractants such as light or baits, population of parasites may be built up earlier. Because of the enormous plant surface of field crops, which form a more or less continuous cover and the comparative low value of the crops per acre, the cost of using any other method than that of accretion would be prohibitive.

The conditions under which the inundative method may be used are often quite the reverse. The plant surface is in most cases much less per acre and forms a broken or "island" cover. More parasites can be liberated per acre because of the high acreage value of the crop. Since in this case a small number of pests can do a great amount of injury and injury by the early generations is relatively great, reproduction of the host should be prevented by continuous liberations. In the control of the Oriental peach moth and codling moth, the eggs must be destroyed before the larva hatches and causes "stings" on the fruit. To accomplish this, parasites must be liberated at intervals timed so that the parasite is always present in numbers greatly exceeding that of the host population. The length of the life cycle of the parasite at field temperature must be ascertained. Since the oviposition of moths attacking fruit trees is more or less periodic, the amount of oviposition comparatively low and scattered in small clusters or singly, the accretive method would rarely be employed with success.

In determining the effectiveness of accretive liberations, it must be recognized that a low percentage of parasitism early in the season when the pest population is low may be more effective than a high percentage of parasitism late in the season when the pest population is high. This is due not only to the elimination of a great potential population but to the actual number *not parasitized*. As the host population in-

creases the percentage value of parasitism decreases. For example, a 50 per cent parasitism of 20 hosts is equal in actual results to 90 per cent parasitism of 100 hosts.

The amount of parasitism is usually determined by observation of the host eggs in the field. Particular care must be taken in making the counts to maintain the actual ratio between the parasitized and unparasitized eggs.

In determining the effectiveness of inundative liberations a count of hatched eggs and vacated parasitized eggs should be made at short intervals throughout the season. The amount of injured fruit at each inspection should be correlated with the percentage of parasitism and total number of host eggs. Some idea of the effect of each liberation can then be obtained. Eggs that are counted should be rubbed off at the time of inspection.

From a practical standpoint, the percentage of parasitism means nothing when considered alone. When correlated with the size of the host population or the amount of crop injury, its economic value can be ascertained. Since the percentage of parasitism is supposedly the same for any part of the population as for the whole, it is obvious that the reduction in host population by natural mortality would not necessarily decrease the effectiveness of egg parasitism. In fact it would have the opposite effect.

In the case of field crops the effect of the natural egg parasitism on the total egg parasitism can only be measured by having numerous check fields throughout a wide area selected as far as possible to take in the extreme variations in natural parasitism. Should a colonized field over a period of years, or a number of colonized fields in a single season, consistently show a higher parasitism and greater reduction in crop injury than most of the checks, the control may be considered due to the liberations.

The checks should have a potential pest population approximately equal to that of the colonized field.

Stanley E. Flanders,
Citrus Experiment Station, Riverside, California

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

OCTOBER, 1930

The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication at $2.50 per page for all matter in excess of six printed pages, a part page counting as a full page, this limit not including acceptable illustrations. Photo-engravings may be obtained by authors at cost.

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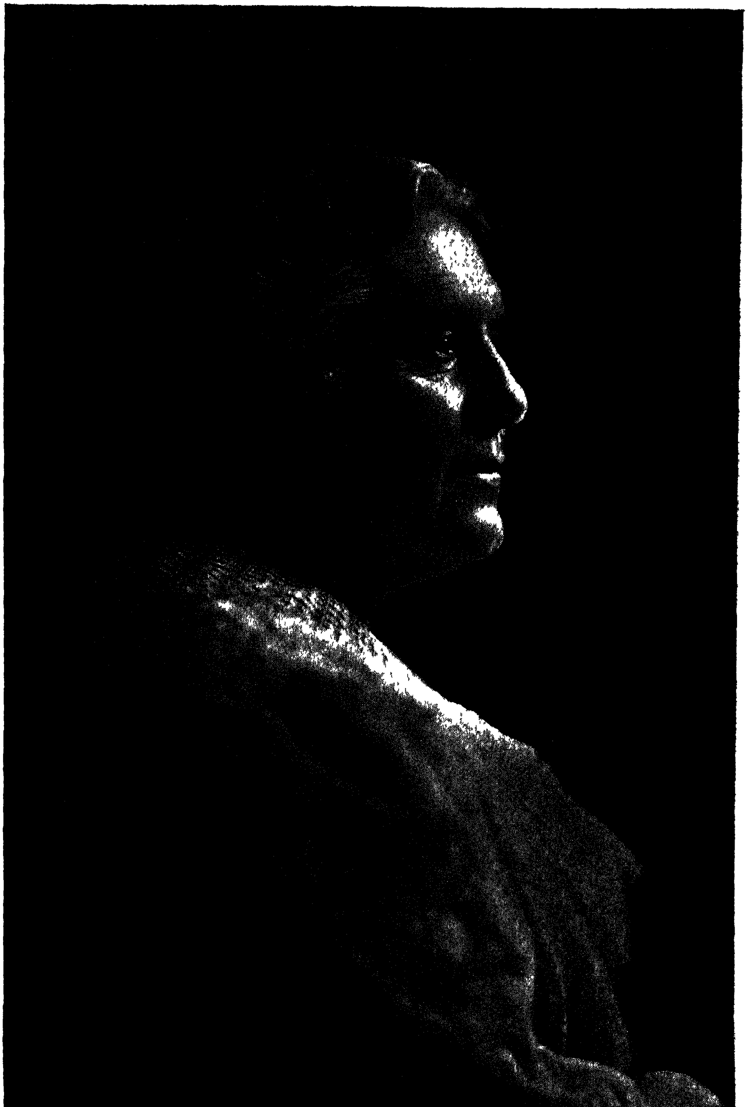
ANNUAL SCIENTIFIC MEETINGS: 1930-31, Cleveland; 1931-32, probably New Orleans; 1932-33, Chicago; 1933-34, undecided; 1934-35, probably Rochester.

Drought relief has been a topic of Nation-wide interest during the last few months and as yet, comparatively little has appeared in the press in relation to the effect of drought upon trees. It is obvious that the immediate effects upon plant life and national prosperity are most evident in annual crops and it is certainly necessary to give due attention to this phase of the problem. Drought is not primarily an entomological problem, though lack of moisture may be favorable to a great increase in certain insects, such, for example, as the chinch bug. There is another phase of the drought problem which entomologists may well recognize, and that is the reduced vitality of trees accentuates injury by leaf eating insects, such as the elm leaf beetle and Japanese beetle and also brings about conditions favorable for invasion by various destructive borers. There is a real opportunity for entomologists in the drought affected areas to point out probabilities, so far as trees are concerned, both fruit trees and shade trees, since these indirect injuries are likely to develop over a period of several years, may have serious consequences so far as the life and vigor of highly prized trees are concerned, and on account of the time involved in the development of certain of these conditions, it is entirely possible to mitigate the evil, even though it may not be possible to entirely avoid it. The beauty and desirability of many residential areas is dependent in large measure upon thrifty shade trees. Many thousands of such trees have succumbed in the past to untoward conditions, and the present is a real opportunity for entomologists to aid in averting serious tree losses during the next few years.



Anna B. Comstock

Obituary

ANNA BOTSFORD COMSTOCK

Born Sept. 1, 1854; died Aug. 24, 1930

ANNA BOTSFORD COMSTOCK, born on a farm in western New York, spent the first ten years of her life among the fields and woods of a beautiful countryside. Here she learned the haunts and habits of the native wild life, came to love and foster the domestic animals of the farm and grew in sympathetic understanding of the problems of farm life.

Undoubtedly she inherited much of her love for nature from her rugged, kindly, wise father who in season followed the cool, wooded streams in quest of the speckled trout and in winter tramped the hills in company with his dog and gun in patient pursuit of the wily fox, while in the autumn, with the aid of his box of sweetened bait, he loved to trace the wild honeybee to her home in some far hollow tree. Being an only child, she became her father's companion in field and wood, where her contact with nature exerted a lifelong influence.

At the age of 16 she entered Chamberlain Institute at Randolph, N. Y. where she prepared for college, and in 1875 entered Cornell University, that young institution which admitted women on an equal footing with men.

Her she became acquainted with Professor John Henry Comstock, and in 1878 they were married. In 1879 Professor Comstock went to Washington as Entomologist of the Department of Agriculture. In this capacity he became interested in the Coccidae and being unable to find an artist who could interpret and depict microscopic structures, he enlisted the talent of Mrs. Comstock who then began the study of the pygidea of scale insects under his direction. She soon proved able to make the drawings which illustrated his classic papers on these insects. Thus she became a student of entomology.

When they returned to Cornell, Mrs. Comstock entered enthusiastically into the work of her husband and began to study the art of wood engraving in order to illustrate the well-known Comstock Manual for the Study of Insects. She soon became a notable artist, especially in her work representing the delicate texture of the bodies and wings of butterflies. Presently, in recognition of her work, she was elected a member of the Society of American Wood Engravers and at the Buffalo Exposition in 1901 her engravings were awarded the Bronze Medal.

In 1896, when the movement in nature study was inaugurated at Cornell, she was asked to assist in the work and was made Assistant in Nature Studies in 1897. In 1907 she became Instructor in Nature Study, in 1913 Assistant Professor, and in 1920 Professor of Nature Study. She became imbued with the idea of awakening within the child a love for the beauties and wonders of nature found in every countryside and on every farm, to the end that this child might eventually become a better, happier, more contented and wiser farm man or farm woman. Out of this fervor came the "Handbook of Nature Study," a volume of over 900 pages which has gone through 15 editions and serves as a text in the schools of every State in this country. In addition it is in use in Japan, China, England, Alaska, Australia and Canada.

Mrs. Comstock also served as editor of the *Nature Study Review* for several years, at the same time contributing many articles on nature subjects to other periodicals. She was the author of several books in addition to the Handbook. These include: Ways of the Six-footed; How to Know the Butterflies (with her husband); How to Keep Bees; The Pet Book; Confessions to a Heathen Idol (a novel); and Bird, Animal, Tree and Plant Notebooks.

She was an Associate Director of the American Nature Association, a member of the Society of American Wood Engravers, a Trustee of Hobart and William Smith Colleges, a member of Sigma Xi and of Kappa Alpha Theta Sorority. In 1923 she was chosen by the National League of Women Voters as one of the 12 greatest living American women.

Perhaps Mrs. Comstock is best known and endeared to many readers of the JOURNAL from the fact that they have been entertained in her home, which for 40 years was a rendezvous for all of Professor Comstock's students. Here she received and entertained with that gracious sympathy and understanding that made every guest a real participant in the life of a lovely home.

G. W. H.

Reviews

The Coconut Moth in Fiji, A History of Its Control by Means of Parasites by J. D. TOTHILL, T. H. C. TAYLOR and R. W. PAINE, pages I–VII, 1–269, 34 plates, a number colored, 119 text figures. Imperial Bureau of Entomology, London, 1930.

This is a most interesting, well written account of a successful attempt to control a serious enemy of coconut, *Levuana iridescens*. A Levuana Committee was organized and after consultation with Dr. G. A. K. Marshall, Director of the Imperial Bureau of Entomology, arrangements were made for the employment of an entomologist and the creation of an organization to make a comprehensive study of the problem, in an effort to secure practical control. The outcome is a striking testimonial of the possibilities of biological control under certain conditions. All responsible for the work are to be congratulated most highly upon its successful outcome.

This volume presents a brief historical account of previous work, a detailed description of the campaign instituted in January 1925, a comprehensive study of the Levuana moth, of the Tachinia fly, *Ptychomyia remota*, and in addition there are studies of allied Zygaenids, of certain parasites of this group and an account of the predaceous beetle, *Callimerus arcufer*. The comprehensive character of the study may well serve as a model for future investigations of this nature and under the relatively simple biological conditions obtaining on many of the Pacific Islands, one may be justified in believing that in such sections biological control is an exceptionally promising method.

E. P. F.

Current Notes

On July 25 Dr. E. W. Dunnam, Bureau of Entomology was reappointed Entomologist with headquarters at Bryan, Tex.

Dr. Wm. H. Mitchell, Jr., accompanied Dr. A. C. Baker to Honolulu, where he will be engaged in research work on the Mediterranean fruit fly.

Prof. W. B. Herms returned to Berkeley on September 10 after giving a series of lectures at the summer session of the Ohio State University.

Everard E. Blanchard, Entomologist, Ministry of Agriculture, Argentina, and Dr. C. H. Richardson, Iowa State College, visited at the University of California early in September.

Prof. E. O. Essig of the University of California has been elected a life honorary member of the California State Association of County Agricultural Commissioners.

Harry M. Jennison and E. K. Bynum have been given temporary appointments as Field Assistants, Bureau of Entomology, for service at Bozeman, Mont., and Phibodaux, La., respectively.

Dr. William Morton Wheeler, for many years dean of Bussey Institution, received the honorary degree of Doctor of Science from Harvard University at its recent commencement.

J. A. Parventjev, of the Pathological Institute, Berlin, Germany, visited the Cotton Insect field laboratory at Tallulah, La., on July 5, to confer with Mr. Coad regarding insecticides.

Dr. W. E. Britton, State Entomologist of Connecticut, received the honorary degree of Doctor of Science from his Alma Mater, the University of New Hampshire, on June 16.

L. H. Dunn, of the Gorgas Memorial Laboratory, Panama City, Panama, spent July 7 to 14 at the Museum, studying the blood-sucking flies, mostly Tabanidae and Simuliidae, in the collections.

Archie Rolfs, a recent graduate of Iowa Agricultural College has been appointed Junior Entomologist, Bureau of Entomology, and reported June 5 for duty at the field laboratory at Yakima, Wash.

W. C. Wooding, Jr., who was employed during July and August at the field laboratory at Danville, Va., has left the service to continue his studies at the University of Virginia.

M. C. Lane of the Bureau of Entomology, Walla Walla, Wash., visited Blairmore, Alberta, Canada, August 27 and 28, where he conferred with Canadian entomologists and others regarding investigations of the wireworm.

L. B. Reed, Bureau of Entomology, who has been investigating the sweet-potato weevil at Picayune, Miss., was recently transferred to Chadbourn, N. C., to assist in investigations on the strawberry root aphid.

Dr. F. Silvestri, of Portici, Italy, visited the field laboratory, Bureau of Entomology, at Yakima, July 3 to 5. On July 4 he was taken on a collecting trip in the mountains west of Yakima.

Temporary appointments as Field Assistants, Bureau of Entomology have been given to R. S. Lehman, for service at Walla Walla, Wash., M. V. Lowe, at Chadbourn, N. C., and C. E. Woodworth, at Madison, Wis.

Dr. C. A. Weigel, Bureau of Entomology, spent August 26 to 29 in Babylon, L. I., taking part in the inauguration of the heat and vapor treatments of narcissus and other bulbous stocks being conducted there.

Mr. H. L. Caler, a recent graduate of the University of Maine, holds the Volck Fellowship (in Entomology) of the Crop Protection Institute at the Kansas State Agricultural College for the current school year.

Mr. B. R. Coad, Bureau of Entomology has gone on an extended western trip, to last probably two months, during which he will visit the field laboratories dealing with cotton insects occurring in western Texas, Mexico, Arizona, and California.

Professor and Mrs. Geo. A. Dean of Manhattan, Kansas, expect to sail from Cherbourg, France, on September 20th, on the "Empress of Scotland," arriving at Quebec on Sept. 27th. They report a very pleasant and profitable sojourn in Europe.

Mr. Ralph Hopping, Entomological Branch, inspected areas in the Grand Forks Trail district, B. C., where the tussock moth, *Hemerocampa pseudotsugata* McD., is epidemic. This insect has increased tremendously during the present year, resulting in severe damage to Douglas fir.

Dr. Wm. H. Mitchell, jr., of the Plant Quarantine and Control Administration, Bureau of Entomology, spent several days in Washington immediately prior to leaving on July 31 for Honolulu, where he will be engaged in research work on the Mediterranean fruit fly.

In New Brunswick, Canada, scouting for the European apple sucker was completed on June 13. As a result of this work it was established that there has been very little spread of the insect beyond the limits of infestation found last year.

Rodney Cecil, Bureau of Entomology, who has been in charge of the field laboratory at Geneva, N. Y., for the study of the Mexican bean beetle, was transferred August 24 to Alhambra, Calif., where he will inaugurate work on the lima-bean pod borer.

On July 1, Doctor W. W. Henderson took the place of the late Doctor Herbert J. Pack as Station Entomologist at the Utah Agricultural Experiment Station. C. J. Sorenson and G. F. Knowlton were advanced from the rank of Assistant to Associate Entomologist, on the same date.

On July 1, Ralph E. Kimport, Agent, Bureau of Entomology, was transferred to this division from the Plant Quarantine and Control Administration, and assigned to a newly established field laboratory at Bay Shore, Long Island, a branch of the Corn Borer Laboratory at Arlington, Mass.

H. A. Jaynes, Bureau of Entomology, stationed in Peru, has sent to New Orleans during the summer almost 170,000 parasites of the sugarcane moth borer. Most of these were the dipterous species *Paratheresia claripalpis*, but there were 10,000 specimens of a species of Ipobracon.

On the first of July, Professor Ray Hutson formerly of Rutgers University, New Brunswick, New Jersey, took up his duties as Associate Professor of Entomology at Michigan State College. Professor Hutson is also a Research Associate of the Experiment Station.

A class in entomology of the University of California spent six weeks during the past summer in the High Sierras, 7000 feet altitude, collecting insects. This summer field trip is a regular thing and required of all students in the Division of Entomology and Parasitology.

A. O. Larson, Bureau of Entomology, who has been in charge of investigations of the bean weevil in California, has been transferred to the Pacific Northwest, where he has been placed in charge of investigations of the pea weevil, with headquarters at the Oregon Agricultural Experiment Station at Corvallis.

Dr. A. C. Baker, Bureau of Entomology, after making a brief stop at the field laboratory at Whittier, Calif., for a conference with the members of the staff there, sailed from Los Angeles August 9 for Honolulu, to reorganize the field laboratory there.

Dr. A. A. Granovsky, of the University of Wisconsin, has accepted an associate professorship in Entomology at the University of Minnesota. Apart from his work on the ecological aspects of insect control, his major problem will be the study of insect transmission of plant diseases, in cooperation with Dr. J. G. Leach, of the Division of Plant Pathology.

Mr. E. B. Watson, Entomological Branch, left Ottawa for the north shore of the St. Lawrence river, Que., on June 9, to continue biological studies on the hemlock looper. Messrs. M. B. Dunn and H. Fleming established a field station at Laniel in the Kippewa district Que., in mid-June, where they are to conduct investigations on the jackpine sawfly infestation.

Mr. Geo. R. Hopping, Entomological Branch, has had charge of airplane dusting operations against the hemlock looper and hemlock tip moth in Stanley park, Vancouver, B. C. The project was sponsored and financed by the Vancouver Parks Board, and the dusting work was commenced on June 15 using flying boats of the Western Canada Airways. The insecticide used was calcium arsenate.

Recoveries have been made this year from points about Boston and Revere, Mass., where colonies of a tachinid, *Chaetexorista javana* B. and B., were put out in 1929. This tachinid is a parasite of the oriental hag moth, *Cnidocampa flavescens* Walk., and the material from which the colonies were obtained was sent from Japan by T. R. Gardner, of the Japanese-Beetle Project.

M. McPhail and C. B. Keck were transferred to the Plant Quarantine and Control Administration, as of August 1, and left Orlando, Fla., for Honolulu, to join the research workers on the Mediterranean fruit fly. En route they stopped at Whittier, Calif., to look over the equipment at the laboratory there. Ralph Marlowe, formerly connected with the research work at Orlando, will also join the staff at Honolulu.

John Gray has been appointed Entomologist, pending certification, and assigned to the study of the ecology of the oriental fruit moth, with headquarters at Moorestown, N. J. Dr. Gray was formerly Professor of Entomology and Plant Pathology at the University of Florida, and has recently received a doctor's degree from Cornell University.

Dr. H. E. Ewing, of the taxonomic unit, Bureau of Entomology reports that as a result of his work in the field during the summer he has discovered two interesting new hosts for the chigger—the mud turtle and the leopard frog. The chigger has been previously found on the box turtle.

Mr. Arthur Gibson, Dominion Entomologist, sailed for England from Montreal, on the S. S. Duchess of Bedford, on June 6, to attend the Third Imperial Entomological Conference held in London, June 17–27. He also was present at the World's Poultry Congress, London, July 22–30, and presented a paper on insect and other external parasites of poultry in Canada.

G. J. Haeussler, Bureau of Entomology, who is investigating parasites of the oriental fruit moth, with headquarters at Antibes, France, reports that several parasites of this insect are present in southern Europe, but are relatively lacking in abundance. He has begun mass rearing of a species of Pristomerus for shipment to the United States.

At the request of the county agents of Cook, Laurens and Lanier Counties, Ga., S. E. McClendon, Bureau of Entomology gave them assistance in August in their work of controlling the corn weevil. Weevils will have a hard time in the western parts of Georgia and South Carolina, where drought is reported to have ruined the corn crop.

Temporary appointments as Field Assistants, Bureau of Entomology, effective July 1, were given to Hugh S. Cavitt, E. F. Knipling, H. B. Tittle, and H. L. Teer, for service at El Paso, Tex., and to S. F. Davis, M. C. Ewing, B. A. Kennedy, W. L. Lowry, H. T. Rainwater, K. R. Vance, Geo. M. Webb, D. H. Allen, jr., and W. H. Lindley, for service at Tallulah, La.

O. C. McBride was transferred from the Bureau of Entomology to the Plant Quarantine and Control Administration, effective August 15, and left Orlando, Fla., on August 25 en route for Honolulu, where he will be in charge of the work being organized there on the Mediterranean fruit fly. This work is to be carried on under the direction of the Bureau of Entomology, but paid for by funds provided by the Plant Quarantine and Control Administration.

Late in June, Mr. R. P. Gorham, Entomological Branch, of the Fredericton laboratory, discovered an infestation of the satin moth at Annapolis Royal, N. S., and a few days later outbreaks were reported in Moncton, N. B. A survey has been commenced to ascertain the extent of these outbreaks and the possible presence of others in the Maritime Provinces. This insect was previously known to occur only in British Columbia, where it was first discovered in July, 1920.

The field laboratory for the investigation of pecan insects at Albany, Ga., formerly located at 515 Flint Street, has been moved to 1503 Jefferson Street. The entomological laboratory is situated in one section of a new two-story brick building, recently constructed by the Chamber of Commerce for all pecan investigations. The building is being occupied not only by the Bureau of Entomology, but also by the division of Horticulture and Plant Pathology of the Bureau of Plant Industry, and the Bureau of Chemistry and Soils.

Professor Filippo Silvestri, head of the Agricultural Institute of Portici, Italy, spent August 28 at Tallulah, where he was shown through the various departments of the field laboratory. He was especially interested in the dusting of cotton by airplanes, and was enthusiastic in his praise of the laboratory's scientific equipment and the extent of its operations. His visit to the South was intended particularly to study at first hand the cane borer and the boll weevil. Before sailing for Italy, at the end of September, Professor Silvestri will visit Columbus, Ohio, the Experiment Stations of New Jersey and Massachusetts, and the Department of Agriculture, at Washington, D. C.

R. A. St. George, Bureau of Entomology, left Asheville, N. C., on July 18 for an assignment at Wisdom, Mont., to determine the practicability of killing *Dendroctonus monticolae* Hopk. in infested lodgepole pines by injecting poison into the trees. A saw is used to make a cut of sufficient size for receiving the poison. Trial will be made for several poisons which were found most promising in experiment work done at Asheville last year, in connection with shortleaf pines infested by the southern pine beetle (*Dendroctonus frontalis* Zimm.). The primary object of the experiment is to find a less expensive method of treating infested trees than the methods in use at the present time. Studies in the medication of trees are being continued at Asheville with pine and with certain hardwoods, and some interesting results have been obtained.

As the result of a two-year investigation of alfalfa meal mills by the Salt Lake station of the U. S. Bureau of Entomology, during which it was shown that alfalfa weevils do not tend to accumulate in the vicinity of mills and that no special precautions are necessary to prevent contamination of meal after grinding, the Western Plant Quarantine Board at its annual meeting in June, 1930, recommended the removal of the embargo maintained by the western states upon the shipment of meal during the summer months. This action follows the delivery at the 1929 meeting of the Board of papers by Doctors Hamlin and Hawley giving a resume of the investi-

gation. These papers were approved for publication by the Bureau of Entomology in October, 1929, and will doubtless be published with the Proceedings in the Monthly Bulletin of the California Department of Agriculture.

Approximately 35,000 adults of the parasite *Macrocentrus ancylivora* have been reared and distributed from the oriental fruit moth field laboratory at Moorestown, N. J., in this season. They were liberated in 70 colonies in important peach-growing centers east of the Mississippi River in which this parasite had not previously been found. In this program, and in supplementary projects undertaken by the Canadian Government and by several States, this laboratory has worked in close cooperation with a number of others. The entomological services of those States have cooperated actively in the work of distribution and recovery. Several States have undertaken mass rearing of this valuable parasite from parasitized material collected in New Jersey. To meet the demand, an additional 400,000 parasitized larvae have been collected and shipped from this center under the supervision of this laboratory. Numerous recoveries have been made and the results to date seem very promising.

On July 3, Congress approved an item of $50,000 for the purchase by the Department of Agriculture of the collection of Lepidoptera built up by the late Dr. William Barnes, of Decatur, Ill. This collection, which is world famous, comprises more than 450,000 specimens, including many types and other accurately compared specimens, and is accompanied by a large library on Lepidoptera and by an extensive card catalog of the North American species. The collection arrived in Washington on the afternoon of August 8, after having been packed and shipped from Decatur, Ill., under the supervision of Messrs. Heinrich and Busck, of the Bureau staff. The collection and accessories made a load of about 45,000 pounds practically filling a large express car and presenting serious difficulties in the matter of proper handling. The collection arrived in excellent condition and is already placed in the National Museum, and so is available for reference and study.

After 31 years of continuous service as head of the Department of Entomology at the Massachusetts Agricultural College, Dr. Henry T. Fernald retired on July 1st, 1930 to devote his time to his study of the Sphecoidean wasps and other researches in Entomology. For administrative purposes, the Departments of Entomology, Zoology and Geology have been combined into a single major department, with Dr. Clarence E. Gordon, Professor of Zoology and Geology, as head. Dr. Charles P. Alexander has been promoted to a full professorship, in charge of the college instruction in Entomology. Dr. G. Chester Crampton continues in charge of all work in Insect Morphology and Phylogeny. Assistant Professor Arthur I. Bourne has been made a Professor, in charge of the research in the Agricultural Experiment Station. Mr. Clayton L. Farrar has been promoted from Instructor in Apiculture to Assistant Professor, and Dr. Harvey L. Sweetman has been appointed Assistant Professor, in charge of the courses in Insect Ecology and Physiology. Dr. Fernald will remain at Amherst until about October 1st, but thereafter will reside at 707 East Concord Avenue, Orlando, Florida.

Starting early Monday morning, July 21 from Maryland approximately forty Maryland growers, County Agents, and specialists gathered at the Japanese Beetle Laboratory at Moorestown, where they were greeted by Dr. Fox and Dr. King who are in charge of the laboratory. The specialists concerned with the different phases of the Japanese beetle situation addressed the assembled Marylanders and then an opportunity was given them to observe the experimental work in progress on soil

treatment, parasite rearing, and other phases of the work. One of the striking things observed was the catch of beetles by five hundred traps that had been in operation fifteen days on a fifteen acre estate north of Philadelphia. A total of five barrels of beetles had been collected in that time. In the afternoon the party proceeded to the vicinity of Mullica Hill where extreme foliage injury to fruit trees and ornamental trees was observed. Spraying operations with poison geraniol sprays designed to attract the beetles into apple trees and kill them when they fed upon the poisoned material were watched with much interest.

On July 28th the following men gathered at the University of Maryland to examine the Mexican bean beetle control experiments being conducted on the Maryland Experimental Farm near Beltsville by Dr. Langford and Mr. Sanders: Dr. Neale F. Howard and W. H. White of the U. S. Bureau of Entomology, Dr. C. C. Howes, Davison Chemical Company; McSherry Lupton, John Bean Manufacturing Company; Dr. R. C. Roark, C. R. Smith, and Mr. Dearborn, Insecticide Division, Bureau of Chemistry; R. C. Burdette, Rutgers College; M. C. Morton, Central Chemical Company; and H. A. Hunter, Canning Crop Pathologist, University of Maryland. Forty-five one-twentieth acre plots were examined from the standpoint of beetle control and plant injury. The sprayed plots included the usual arsenical applications alone and in combinations with various adhesives and Bordeaux; also a similar series using barium fluosilicate, sodium fluosilicate and cryolite. A large series of dusting experiments were of much interest. New fluoride compounds developed by Dr. Roark and Dr. Howes were under test. Each plot contained four rows with the records being taken from the two middle rows.

From June 8 to July 7 (1930) Professor Franklin Sherman, with Mrs. Sherman and two of their children, Joseph and Grace, made a long auto tour from Clemson College, S. C., which was partly recreational, partly to attend to matters of the Association of Economic Entomologists and its meetings of next winter at Cleveland, and partly to visit departments of Entomology and Zoology at various places. By previous arrangement consultations were held at many institutions while others were viewed or visited more casually by driving through the grounds and among the buildings. Among the places visited were, Berea College in Kentucky, University of Kentucky, Ohio Experiment Station, Michigan State College, University of Michigan, Ontario Agricultural College at Guelph, University of Toronto, Queen's University at Kingston, Dominion Entomological Branch in Ottawa, Dominion Central Experimental Farms, Canadian National Museum, City of Quebec, Museum of Comparative Zoology at Harvard University, U. S. Gipsy Moth Offices, Massachusetts Agricultural College, Amherst College, Bronx Zoological Park, West Point, Cornell University, Smithsonian Institution, and North Carolina State Department of Agriculture.

The tenth annual meeting of the International Great Plains Crop Pest Committee was held under the auspices of the Lethbridge Dominion Entomological Laboratory on August 28–30, 1930. The meetings were held at the Greenhill Hotel, Blairmore, Alberta. The following men attended the meetings: Mr. H. G. Crawford, Chief of the Division of Field Crop and Garden Insects, Dominion Entomological Branch, Ottawa, Ontario; Prof. R. A. Cooley and Mr. G. A. Mail, of the Montana Experiment Station, Bozeman, Montana; Dr. J. R. Parker of the U. S. Bureau of Entomology, Bozeman, Montana; Dr. M. C. Lane of the U. S. Bureau of Entomology, Walla Walla, Washington; Prof. E. H. Strickland, University of Alberta, Edmonton;

Mr. S. H. Vigor, Field Crops Commissioner, Saskatchewan, Dept. of Agriculture, Regina, Saskatchewan; Messrs. N. Criddle and R. H. Handford, Dominion Entomological Laboratory, Treesbank, Manitoba; Mr. Brown of the Dominion Inspection Station, Estevan, Saskatchewan; Mr. K. E. Stewart, Dominion Entomological Laboratory, Indian Head, Saskatchewan; Messrs. K. M. King, E. McMillan and L. Paul of the Dominion Entomological Laboratory at Saskatoon, Saskatchewan; Mr. E. R. Buckell of the Dominion Entomological Laboratory at Vernon, B. C.; Mr. Eric Hearle, of the Dominion Entomological Laboratory at Kamloops, B. C.; Messrs, H. L. Seamans, G. F. Manson, C. W. Farstad, R. W. Salt, and J. H. Pepper, of the Dominion Entomological Laboratory at Lethbridge, Alberta. Dr. Niedig of the Consolidated Smelters, Trail, B. C. and Mr. F. S. Carr of Medicine Hat, Alberta, attended some of the sessions. Miss C. Coutts of the Dominion Entomological Laboratory of Lethbridge, Alberta, was secretary of the meetings. Several of the members were accompanied by their wives, and families.

Horticultural Inspection Notes

Mr. C. George Anderson has been transferred from New York to port inspection at San Juan, Porto Rico, effective September 1.

Mr. Marcus A. McMaster, formerly employed as a Junior Plant Quarantine Inspector, was reinstated August 25 for duty at the port of New York.

Mr. Herman T. Pinto received an appointment as Junior Plant Quarantine Inspector, effective July 16, and has been assigned to the port of El Paso, Texas.

Messrs. Claude E. Post and Pablo Ortiz received appointments as Junior Plant Quarantine Inspectors on July 16 and 21 respectively and have been assigned to the port of New York.

Mr. W. B. Wood of the District of Columbia inspection service, inspected imported date palms and certain special permit material being grown in southern Texas during the month of August.

Mr. L. S. McLaine, Chief of the Division of Foreign Pests Suppression of Canada, reports that the satin moth has been causing increasing injury in the southwestern part of British Columbia.

Mr. Robert L. Trigg was transferred from the port of New Orleans on June 27 and placed in charge of the port inspection work at Gulfport, Mississippi. Mr. R. W. Nicaise who has been stationed at the port of San Juan since 1928 has taken Mr. Trigg's place at New Orleans.

The Plant Quarantine and Control Administration has begun the issuance of a series of circulars giving the plant quarantine restrictions of various foreign countries. Those issued thus far relate to the requirements of Cuba (PQCA-283), Mexico (PQCA-284), and Italy (PQCA-289).

A European corn borer conference was held at Toledo, September 24 and 25, with headquarters at 615 Front St. The program included field trips, a business meeting, short talks, exhibits and demonstrations of the latest in implements and machinery.

The southern division of the American Phytopathological Society held its annual meeting and field trip in Mississippi, June 12 to 16. Among the subjects given special field attention were the bacterial canker disease of tomato, the phony disease of peach, and methods of dusting pecan orchards.

Drs. J. H. Montgomery and H. H. Hume of the State Plant Board of Florida, spent several days in Washington early in August, discussing with members of the Plant Quarantine and Control Administration, anticipated modifications of the State rules and regulations pertaining to the Mediterranean fruit fly.

The California State quarantine pertaining to Downy Mildew of Hop (No. 14) was revised effective July 11, 1930, to prohibit the entry of hop sets, hop roots or hop cuttings from Canada or from any State in the United States. Prior to this revision, the quarantine did not apply to entry of these materials from the State of Oregon.

Dr. Carlos Chardon, Commissioner of Agriculture and Labor, San Juan, P. R., who is the ex officio plant quarantine officer of that Territory, spent several weeks in Washington in September, attending the inter-American conference on agriculture, forestry and animal industry, and discussing various agricultural problems with members of the Federal Department of Agriculture.

The Federal European corn borer quarantine regulations were amended, effective August 1, to add to the regulated area all that part of New Hampshire which had not previously been included, and were again amended on August 20 to release from restriction shelled corn, the cut flowers or entire plants of cosmos, zinnia or hollyhock, as well as oat and rye straw and celery.

A hearing to give renewed consideration to the advisability of extending the Japanese beetle quarantine to include the State of Rhode Island has been announced by the Secretary of Agriculture, was held at the offices of the Plant Quarantine and Control Administration at Washington, D. C., on October 3. Immediately following the hearing there was a general conference on the Japanese beetle quarantine regulations.

The State Plant Board of Florida met at Jacksonville on August 11, 1930, to discuss the Mediterranean fruit fly quarantine regulations, and adopted a revision of the State regulations relating to the eradication of this pest and to the intrastate movement of restricted articles. The revised restrictions are closely coordinated with the Federal plant quarantine regulations but include many additional details relating particularly to fruit fly extermination.

The Federal Department of Agriculture on July 23 issued circular PQCA-285, calling to the special attention of permittees importing nursery stock for propagation under Regulation 14 of Quarantine 37, the importance of compliance with the requirements governing the segregation and labeling of imported plants. The requirement as to a map or chart showing the location of the imported stock will hereafter be required only when difficulty in locating the imported plants makes such a chart necessary.

An informal conference to give consideration to certain problems connected with the maintenance of road stations around the area regulated on account of the one-generation strain of the European corn borer was held in the offices of the Plant Quarantine and Control Administration on August 13. Many of the Mississippi

Valley and Lake States were represented, and communications on the subjects before the conference were received from the quarantine officers of most of the other States of that section.

A recent paper of interest to plant quarantine officials is "*Dasyscypha fusco-sanguinea* Rehm on Western White Pine, *Pinus monticola* Dougl.", by C. R. Stillinger, published in Phytopathology, June, 1929. Mr. Stillinger reports that this disease occurs on five-leafed pines in the white-pine belt of northern Idaho, northeastern Washington, and northwestern Montana, and is so similar to white-pine blister rust that on superficial examination one may be mistaken for the other. The disease has not previously been reported as an active parasite on western white pine. The paper gives methods of differentiating this disease from the blister rust.

The executive committee of the Eastern Plant Board held a meeting on July 22, at the Hotel Benjamin Franklin, Philadelphia. Members of the committee present included President T. J. Headlee, Dr. W. E. Britton, Dr. G. T. French, Dr. J. F. Adams, F. A. Bevan representing Dr. A. W. Gilbert, and Dr. E. N. Cory. Messrs. L. H. Worthley and C. H. Hadley of the United States Department of Agriculture, and G. S. Langford of the University of Maryland, were also present to take part in the discussions and make reports. Dr. J. F. Adams was appointed by the executive committee to fill out the unexpired term of Dr. W. A. McCubbin as representative on the National Plant Board.

An inter-American conference on agriculture, forestry and animal industry was held in the Pan American Building at Washington, D. C., September 8 to 20, 1930. In addition to many representatives of the United States Department of Agriculture and of Porto Rico, delegates registered from Mexico, Cuba, The Dominican Republic, Haiti, and from sixteen Central American and South American countries. Among these were a number of plant quarantine officers, and subjects relating to insect pests, plant diseases, and quarantine and control measures, elicited general discussions. The general subject of plant quarantine and control measures was presented to the conference in a paper prepared by Mr. Lee A. Strong.

Under State Proclamation No. 36, dated August 20, 1930, the Commissioner of Agriculture of Texas issued regulations governing the growing and marketing of cotton in the pink bollworm infested area of that State. The regulations control the storage and use of seed cotton, and the movement from the regulated zones to points outside, or from one county to another within the zones, of seed cotton, cottonseed, cotton lint, and other parts of the cotton plant. It is further required that operators of both cotton gins and cotton oil mills, located either within or outside the regulated areas shall obtain authorization from the State Entomologist before ginning cotton from the regulated zones or crushing cottonseed from these zones.

The State Plant Board of Mississippi reports increasing losses from bacterial canker of tomato in that State. Two papers on this subject are included in the Quarterly Bulletin of the Board for July, 1930, one by Mary K. Bryan, Associate Pathologist of the Federal Department of Agriculture, and the other by Dr. L. M. Fenner of the State Plant Board. The disease is said to be present in nineteen States and also to occur in Canada, Italy and Germany. It was first reported to the Board in 1925 and 1926, but is now being repeatedly reintroduced into Mississippi with contaminated tomato seed from northern sources of supply. The State Plant Board

has made out a list of seed sources which furnished cankerfree seed for the 1930 crop, and is now giving consideration to the possible methods of protecting the growers for the crop of 1931.

Appointments and transfers for the organization of transit inspection to aid in the enforcement of Federal domestic plant quarantines for the fall nursery stock shipping season, together with the points to which the men will be assigned, include the following: F. J. Baker, Chicago, Ill.; C. M. Chapman, Ogden, Utah; H. E. Crossley, Spokane, Wash.; W. J. Cullen, Chicago, Ill.; G. H. Curtis, New York City; B. A. Ganoung, Seattle, Wash.; A. J. Lambert, New York City; G. W. Nelson, Minneapolis, Minn.; Carl O. Peterson, Portland, Oregon; T. L. Thompson, Kansas City, Mo.; R. E. Wheeler, Omaha, Nebr. and George M. Whiting, Spokane, Wash.

The California State quarantine pertaining to the alfalfa weevil (No. 7) was revised effective June 20, 1930, to cover three essential changes. The county in Nebraska under quarantine for this insect was changed from Scotts Bluff to Sioux County. This change was based upon the fact that the infestation was found near a county line and it was originally assumed that it occurred in Scotts Bluff County. However, later it was found to be in Sioux County as now specified in the revised quarantine. The second change provides for the admittance during the entire year of alfalfa meal from mills unquestionably equipped to prevent contamination of the finished product during the summer months or the active period of the weevil. A further change provides for the admission of ornamental and nursery stock without the fumigation and certification formerly required at origin.

The New Jersey Department of Agriculture, in June, published Circular No. 182, by Nathaniel A. Back, entitled "A Study of the Economic Costs of Quarantines in New Jersey." The author concludes that the quarantines are responsible for taking approximately "one-fifth of the total net income of certain large nursery and greenhouse concerns" of New Jersey, but that "the spread of the regulated area, in conjunction with the perfection of more efficient and less costly methods of treatment for certification, has resulted and should continue to result in reduced costs to those affected by the quarantines in this State." The author says that no attempt is made to evaluate the quarantines; that is, to weigh the value of holding up the spread of the insects against the cost involved in the process. The publication was prepared before the quarantine on the Asiatic beetle was revoked, but in a footnote it is stated this does not affect the results set forth in the remainder of the study.

The California State Department of Agriculture has issued as special publication No. 99 a report of the pest interceptions at California port inspection points for 1929. The report shows the examination of 3,695 vessels, 62,917 passengers, and 5,934,256 parcels of horticultural imports at San Francisco; 4,758 vessels, 24,264 passengers, and 2,310,092 parcels of horticultural imports at San Pedro (the port of Los Angeles), and 829 vessels, 6,617 passengers, and 388,537 parcels of horticultural imports at San Diego. It also shows the inspection of 1,720 airplanes and 5,990 airplane passengers at San Diego, and 537,417 automobile and 3,782 train inspections. The list of species and hosts of insect pests and plant diseases includes 640 different species of insects, mites and other animal hosts, and 25 different species of fungi, bacteria and nematodes collected at the maritime ports, and about half as many interceptions at border stations are noted. The most important interceptions reported relate to the Mediterranean fruit fly, the melon fly, the cherry fruit fly, the Oriental fruit moth, the nut codling moth, the pink bollworm of cotton, the sweet potato weevil, the Japanese rose beetle, the camphor scale, the rose scale, the citrus

canker, and a number of other serious insects and diseases which do not occur in California, as well as many pests not of general distribution in that State.

Effective August 15, 1930, the Secretary of Agriculture issued a revision of the Federal Mediterranean fruit fly quarantine regulations, incorporating changes in and interpretations of the previous requirements which had been issued as administrative instructions, and in addition making a number of important changes of interest to growers and shippers. Among the changes of general interest are (1) the authorization of the movement of sterilized fruit and of unsterilized tomatoes, eggplants and lima and broad beans from the regulated area of Florida to the southern and western States throughout the entire shipping season or until further notice; (2) authorization to the State Plant Board to reduce the size of the infested area to include properties within one-half (in place of one) mile from points of infestation; (3) the discontinuance of the requirement of sterilization for fruit shipped to the middle western States from points outside the infested areas; (4) the addition of blackberries, dewberries, mulberries, cotton bolls and seed cotton to the list of products which are exempt from the fruit fly requirements; (5) the extension of the harvesting and marketing period of the commercial Florida citrus crop to June 15, 1931, and (6) the removal of the reshipment regulations under which the transportation of Florida host fruits and vegetables from the northeastern States to the middle West was restricted. All administrative instructions previously issued under Quarantine No. 68 were cancelled but the subject matter of those which related to methods of sterilization of citrus fruits and avocados was immediately reissued in condensed form as circulars PQCA-290 and PQCA-291.

The twelfth annual conference of the Western Plant Quarantine Board was held at State College, N. Mex., June 12 to 14, 1930. A number of resolutions were adopted relating, respectively, to commendation of the Mediterranean fruit fly eradication campaign in Florida; to surveys in other southern States for infestation of the same insect; to an indorsement of the pink bollworm eradication program, and of plans "looking to cooperation with the Republic of Mexico for the banishment of pink bollworm from this continent;" to the need for a comprehensive study in foreign countries of such pests as appear capable of causing important pest problems in the United States; to the desirability of having the Federal Department summarize available data on pest treatments and have investigations made to determine additional treatments which may be of value; to weed control; to the interstate control of shipments of honey bees; to the desirability of having the Federal Department prepare a compilation of legal data, statutes, court decisions, etc., which have been accumulated as a result of agricultural quarantine litigation in courts of the United States, and to the need of devoting greater attention to car cleaning and confining car loads of agricultural products to single-walled cars. Other subjects discussed included the report of the alfalfa meal committee, of which M. L. Dean of Idaho was Chairman, in which it was stated that the type of equipment necessary to safeguard against alfalfa weevil contamination is now in operation at one or more places. D. B. Mackie, Chairman of the committee on pest treatment, gave up-to-date information relative to the use of Ethylene oxide and chloropicrin. At the close of the meetings, Dr. H. L. Kent, President of the New Mexico College of Agriculture and Mechanic Arts, was elected Chairman for the ensuing year; A. G. Stephens, Entomologist of the State of Wyoming, Vice-Chairman; W. C. Jacobsen of the California Department of Agriculture, as Secretary and as representative on the National Plant Board with Dr. O. C. Bartlett, whose term of office has not yet expired.

Apicultural Notes

The Cornell Beekeeping Library is now receiving a large collection of Russian beekeeping literature by exchange with workers of that country.

Dr. M. Hajdak, formerly of the Institute of Beekeeping at Dol, Czechoslovakia, has been appointed Field Assistant at the Bee Culture Laboratory, Bureau of Entomology.

A. A. Woodrow, C. C. Gillette, Thomas White, and Charles J. Bangham, graduate students in apiculture at Cornell University, are spending the summer in apiary inspection work in New York State.

Norman E. Phillips has resigned his position in the Department of Zoology at Syracuse University and will take graduate work at Cornell University during the coming year.

"Beekeeping" by Prof. E. F. Phillips of Cornell University has just been issued in a Russian translation by A. S. Mikhailoff of the Tula Apiculture Experiment Station, under the editorship of F. Tunin of the same Station.

Professor E. F. Phillips took part in the program for beekeepers during Farmers Week at the University of Missouri in July and also in the meeting during Farmers Week at the Massachusetts Agricultural College on August 1.

Jes Dalton, of Kenner, La., Associate Editor of the Beekeepers' Item, visited the Bee Culture Laboratory on July 16 and 17, to confer with the members of the staff concerning various problems of interest to beekeepers in the Southern States.

A second manuscript volume of the personal Journal of Rev. L. L. Langstroth has recently been discovered by members of his family and has been placed in the Cornell Beekeeping Library. The transcription of the first volume is almost completed.

E. J. Dyce of the Ontario Agricultural College, who has been taking graduate work at Cornell University during the past year, has been granted a scholarship for next year so that he may continue his studies on the fermentation and granulation of honey.

Professor E. F. Phillips of Cornell University was recently elected to honorary membership in the Hungarian National Society for Bee Culture, on the occasion of the fiftieth anniversary of that Society. Prof. Enoch Zander of Erlangen and Prof. Ludwig Armbruster of Berlin-Dahlem were similarly honored.

Interest in bees for pollination has recently increased greatly in the fruit section of New York and several hundred more colonies than before have been moved into these areas. Mr. George H. Rea of Pennsylvania who was formerly Extension Specialist in Apiculture at the New York State College of Agriculture was appointed temporarily to assist the fruit growers in the proper care of these bees.

E. L. Sechrist, Bureau of Entomology returned on August 4 after visiting the cooperators who are helping in the studies on apiary management and costs of honey production, in Ohio, Iowa, Minnesota, and Michigan. This work is being done in cooperation with the Bureau of Agricultural Economics, and with the beekeeping specialists in the various States. Some of the State specialists in economics are also taking an active part in these studies.

Dr. Lloyd M. Bertholf, Field Assistant, Bureau of Entomology, at the Bee Culture Laboratory, resigned on August 20. Doctor Bertholf, in company with Mrs. Bertholf sailed on August 23 for Scotland, on his way to Munich, where for the coming year he will study with Doctor von Frisch under a National Research fellowship. En route, Doctor Bertholf will attend the meeting of the Apis Club International Conference, at London, on September 8 to 12, where he will deliver a lecture on the results of his recent experiments on the response of honeybees to light of different wave lengths.

W. B. Bray, one of the largest honey packers in New Zealand, executive of the National Beekeepers' Association of New Zealand, and owner and editor of the New Zealand Honey Producer, visited the Bee Culture Laboratory, Bureau of Entomology September 2 and 3. He is making an extended trip through Europe, Canada, and the United States, in the interest of honey marketing. Mr. Bray reports that through Government assistance New Zealand has made great strides in honey marketing, and he was particularly interested in learning what is being done in this country along that line. In the course of his stay in Washington he visited officials of the Bureau of Agricultural Economics and the Bureau of Chemistry and Soils.

At the request of Prof. Eric Millen, Provincial Apiarist, Ontario Agricultural College, Guelph, Dr. C. E. Burnside consulted with the apicultural staff of that institution and the provincial inspectors concerning the unusual conditions observed this season in colonies infected with European foulbrood. The conditions found in the diseased colonies were of such a nature that field diagnoses were made under great difficulty. To a certain extent similar difficulties have been experienced in the United States during the present season. In many cases it has been possible only by the use of the microscope to make definite diagnoses of European foulbrood, because of its close resemblance to American foulbrood. Doctor Burnside also consulted with the bacteriologists at the college.

The Maryland State Beekeepers' Association held its annual summer meeting at the Bee Culture Laboratory on July 19. In the forenoon members of the staff gave short talks. After a picnic lunch which was served in the laboratory grounds several contests were held. It has become an annual event at the summer meeting of the Maryland State Beekeepers' Association to choose "the best beekeeper in the State." The title was decided this year by the beekeeper catching the most live bees and placing them in a wide-mouthed bottle without getting stung. A. Howard Johnson, of Centerville, Md., President of the State Beekeepers' Association, carried off the honors. A contest was also held to test the skill of the beekeepers in identifying various diseases of bees, and was won by Harold L. Kelly, of Forest Glen, Md. Pathe News Motion Pictures made "talkies" during the contests.

Dr. Warren Whitcomb, Jr., of the Southern States Bee Culture Field Laboratory, Baton Rouge, La., reports that at the meeting of the State Association of Queen Breeders and Package Shippers, which was held in conjunction with the meeting of the Texas State Beekeepers' Association, at College Station July 28 and 29, the package producers were well pleased with the progress being made by the Southern States Bee Culture Field Laboratory in recommending a satisfactory and uniform cage which could be used indiscriminately by all shippers of package bees. Doctor Whitcomb says that the use of a uniform package by the shippers will eliminate a great deal of confusion in the package-bee business, and that it will particularly

enable the express companies to facilitate shipment. The cage that the laboratory has been working on is simple in construction, is therefore economical, and makes it possible to ship the bees with as little loss as the more expensive and complicated cages now being used by a number of shippers of package bees.

The Texas Beekeepers Association held their annual meeting at College Station, and enjoyed an appropriate program, prepared by Dr. S. W. Bilsing, Head of the Department of Entomology, A. & M. College and Dr. F. L. Thomas, Chief of the Division of Entomology, Texas Agricultural Experiment Station. While the key note of the meeting was co-operation, several papers on local practices were presented. Dr. E. G. LaMay, State Board of Health, presented a paper on the Violation of Pure Food Laws. Cecil Heard, and W. M. Whitney, of the State Inspection Service told of their work. H. B. Parks, Chief of the Division of Apiculture and E. W. Cothran, told of the research work in beekeeping. Dr. E. W. Paulson, Division of Economics, Texas Agricultural Experiment Station, discussed co-operative marketing. Dr. Warren Whitcomb, Southern Field Laboratory, U. S. D. A. Baton Rouge, La., explained the specifications adopted, by their station as standards for crates in which bees are shipped. The Association went on record, as continuing its support of the American Honey Producers League, The Honey Institute, and the Southern Beekeepers Conference.

H. B. Parks,
San Antonio, Texas.

Notes on Medical Entomology

F. C. Bishopp, Bureau of Entomology, visited Gibson Island, in the upper Chesapeake Bay, on July 5 to look into the problem of ticks and chiggers, which are seriously annoying residents there.

Dr. W. V. King, Bureau of Entomology, who spent most of July in Portland, Oregon, on business relating to the mosquito project, left there for his official headquarters at Mound, La., July 26.

R. W. Wells, Bureau of Entomology, of the field laboratory at Galesburg, Ill., is temporarily located at the field laboratory at Beltsville, Md., where he is conducting tests of electrified screens for the control of house flies.

F. C. Bishopp, Bureau of Entomology, spent the entire month of August in field travel. He made stops at the field laboratories at Galesburg, Ill., Fargo, N. Dakota, and Portland, Oregon, and visited many intermediate points to make observations on insects injurious to livestock.

W. E. Dove, Bureau of Entomology, who has been placed in charge of investigations of the sand fly, with headquarters at Charleston, S. C., arrived there August 19 to take up his duties under the new assignment.

On July 17 F. C. Bishopp, Bureau of Entomology attended a conference of physicians and health officers concerning the recently reported cases of typhus fever in Maryland. Much interest was shown in the likelihood of transmission of the disease through the agency of insects and ticks.

E. G. Green, of Natal, Rio Grande de Norte, Brazil, called at the Bureau of Entomology about July 10 and discussed parasites of the pink bollworm, incidentally offering to cooperate in a further study of such parasites in Brazil, with a view to their ultimate importation into this country.

Mr. C. R. Twinn, accompanied by Mr. G. H. Fisk, both of the Entomological Bureau, visited the Montreal and Hemmingford districts, Que., June 23–27, in connection with mosquito investigations. Particular attention was paid to mosquitoes of the genera *Culex* and *Mansonia* in the St. Pierre swamp at Montreal, and to *Anopheles* and *Culex* in the extensive swamps occurring in the Hemmingford district.

JOURNAL
OF
ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Vol. 23 DECEMBER, 1930 No. 6

LABORATORY TESTS OF MISCELLANEOUS CHEMICALS AGAINST THE CODLING MOTH

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Abstract

During the years 1920 to 1928, inclusive, studies were made to determine the toxicity of many materials to newly hatched codling moth (*Carpocapsa pomonella* L.) larvae. Numerous tests were made in a rather hasty survey for a possible arsenical substitute with the idea of helping to develop a poison which could be used in a practical way and which would not be objectionable on fruit at harvest. Although no chemical was found which could substitute for lead arsenate in a practical way, several materials were strongly toxic to codling moth larvae.

The recent objection to fruits and vegetables sprayed with arsenicals reaching the market with excessive spray residue has suggested the development of a material which can be substituted for the arsenicals in the control of certain chewing insects. With the idea in mind of finding a material which would be toxic to insects and non-toxic to man as well as meet certain other requirements of a stomach poison, studies were begun in the early summer of 1926 to determine the toxicity of many materials of promise and others which had never been tested before as insecticides. The primary reason for conducting these tests was to obtain indications of effectiveness of the materials tested for preventing entrance of codling moth larvae into treated apples under the conditions of the experiments. Little attention was given to other features of the materials tested. The results of these tests, against newly hatched larvae of the codling moth (*Carpocapsa pomonella* L.), conducted during the years of 1926, 1927, and 1928, are reported in this paper.

Methods and Technique. The method employed in these experiments is similar, with a few minor changes, to that used by R. H. Smith (*5*)[1] and by E. J. Newcomer (*4*). This method when employed

[1]Reference is made by italic numbers in parentheses to "Literature Cited," P. 922.

against the codling moth avoids many of the uncontrollable factors met with in orchard work. Accordingly, a large number of laboratory tests were made consisting essentially of spraying a given number of apples, placing a given number of newly-hatched codling moth larvae on them, and later recording the number of worm holes and stings. This method can be used to show the relative value of various materials, of various dilutions of each material, and of combinations with other spray materials. The ease with which this method can be employed enables the investigator to carry out a large number of tests in a single season and to make direct comparisons of a large number of treatments. Obviously, this method gives only an index of the value of the material used at the time it is applied. It is of no value in determining the durability or adhesiveness of the material, or of the relative effect of various methods of application (such as by means of a spray gun or rod), or of the various numbers of applications. Nearly 2,000 tests of this nature, in which 46,960 newly hatched larvae were used, have been made at the fruit-insect laboratory of the United States Bureau of Entomology at Moorestown, New Jersey.

SECURING NEWLY HATCHED LARVAE. Burlap bands were placed around the trunks of apple trees at Glassboro, New Jersey, which were heavily infested with the codling moth. From these bands thousands of over-wintering larvae were collected. These larvae were placed in battery jars containing corrugated paper strips cut to a convenient size, and in these the larvae developed. The development of many of the larvae was retarded in the late spring by placing them in a space formed between two cold storage rooms where the temperature was continuously about 45°F. The purpose of retarding the development was to prolong the period of emergence of adults. This prevented all of the moths from coming out at one time and gave a continuous supply of adults.

The newly emerged moths were placed in cages to lay eggs. The cages were 6 inches by 6 inches by 12 inches in size and so constructed that the 16-mesh wire screen was attached inside the supports. A covering of moist sand about one-half inch thick had been previously placed in the bottom of each cage and covered with 16-mesh wire screen to prevent the moths depositing eggs in the sand. Fresh pear foliage was inserted for the deposition of eggs. Approximately 100 moths equally divided as to sex were placed in each cage. The pear foliage was replaced each day and the eggs on the leaves and stems counted and placed in separate jars. As soon as the black spot appeared the eggs were transferred to a clean jar. The newly hatched larvae were easily removed from the side of the glass jar, where most of them went.

PREPARATION OF APPLES. Unsprayed apples of Grimes Golden variety and free from injury of any kind were used for all tests. The apples ranged in size from 1 inch to 2 inches in diameter. The calyx cups were filled with paraffin and each apple was suspended by a piece of black cotton thread tied to its stem. Five apples were used in each test and for ease of handling the apples were suspended by different lengths of thread tied to a single strip of wood, the distance between apples being about three inches.

SPRAYING AND DUSTING. A hand sprayer of 1-quart size was used to apply the materials used in sprays. Each apple was slowly rotated to insure a thorough covering of material. The coverage was not always uniform but it was of such a nature that the insect eating the apple would first have to eat through some of the spray deposit. The spray was applied until the drops ran together, but application was stopped before any of the solution ran off the apple. All the materials mentioned in Table 1 were applied as sprays.

Most of the materials were applied in the form of a dust. If the material to be tested was not already fine enough, it was ground to a fine powder. The liquid materials were incorporated with an inert carrier by grinding the liquid with the carrier in a mortar. The carrier used in these experiments was talc. Previous to dusting, the apples were sprayed with water to cause the dust to adhere in an even film. All the materials mentioned in Table 2 were applied as dusts.

TRANSFERRING THE LARVAE. In agreement with an observation made by Smith (5) it was noted that the first larvae to hatch from a lot of eggs usually showed greater vigor than those which hatched last. The experimental results obtained do not, however, bring out any greater susceptibility of one lot of larvae than of another lot. Larvae hatching from eggs whose development had been retarded by being placed in cold temperature were less vigorous than those whose development had been unchecked.

The work was so arranged that only newly hatched larvae were used. No particular attention was paid to the length of time after the spray application until the larvae were placed on the apples except in the case of those sprays used as contact poisons. A small camel's-hair brush or a needle point was used in transferring the larvae. This was accomplished by having the larva attach its silk thread to the needle point or brush and gently lifting the larva in midair to the apple. The brush was kept soft and flexible by moistening it frequently. Considerable care was exercised to prevent injury to the larva and to place it ventral side down

so that it could make contact with the surface of the apple with its legs. Five larvae were used to each apple and five apples to each test.

Laboratory Conditions. These studies were conducted in an open insectary where ventilation was easily controlled. This prevented rain or wind from interfering with the apples which were suspended.

Determination of Injury. The injury was recorded as of two forms. An entrance corresponds to the term "worm" commonly used in codling moth writings. Injury recorded as an "entrance" means that a larva has eaten through the skin of the apple and into the tissues without receiving a lethal dose of the poison. Injury recorded as a "sting" means that a larva attempted to enter the apple, but because of the effects of the poison or from other causes ceased eating after making a slight pit in the skin or, at most, a small excavation in the tissue of the apple. A feeding injury one-fourth inch or less in depth was recorded as a sting.

Nine days after the application of the larvae an incision approximately one-fourth inch deep was made under each injury. Any burrow which extended deeper than one-fourth inch was recorded as an "entrance." Injuries of less extent were considered "stings" unless the larvae were found alive. Most of the stings were so slight that they would have escaped notice on the surface of a growing apple. Observations indicated that only rarely would a larva make more than one injury. In this report it is considered that the number of injuries corresponds with the number of larvae making them.

Results of Tests. In presenting the results of these tests in the tables, it has been necessary to give only the summary of all of the tests made with any given material. The total number of larvae used in each case is shown. The number of stings, the number of entrances, and the percentage of worms producing worm holes are recorded. The percentage of efficiency given for each material was calculated by the method described by Abbott (*1*). In all experiments untreated checks were run at the same time and in all of the tests comparison is made with powdered lead arsenate applied as a spray and as a dust; this being considered the standard treatment.

Variations in the percentage of entrances into the treated fruit as well as into the check fruit are to be expected and are unavoidable. This variation, however, should not affect the purpose of the experiments, since no attempt is being made in this preliminary survey of a large group of materials to draw conclusions from narrow differences.

CASEIN SPREADER. Several investigators have published results which showed that the addition of casein spreaders to insecticides either increased or did not decrease their efficiency. Lovett and Robinson (*2*) reported 50 per cent increase in effectiveness when casein spreader was used in orchard tests against the codling moth in 1918 and 1919. Stearns and Hough (*6*) reported no difference in results against the codling moth and other chewing insects. Newcomer (*3*) obtained slightly better control of the codling moth in the orchard with the spreader added to the lead arsenate than without, and from laboratory tests in 1923 and 1924 he reported that all tests with spreader gave better results than where no spreader was used. Similar tests were made at Moorestown. New Jersey, in 1927 and the results are shown in Table 1.

TABLE 1. COMPARISON OF THE EFFECTIVENESS OF DIFFERENT ARSENICALS AND FLUOSILICATES USED AS SPRAYS WITH AND WITHOUT CASEIN SPREADER AGAINST THE LARVA OF THE CODLING MOTH, MOORESTOWN, NEW JERSEY, 1927 AND 1928

In Amounts Equivalent to 1 Pound of Lead Arsenate to 50 Gallons of Water

Material	Number of larvae used	Number of stings	Number of entrances	Per cent entrances	Per cent efficiency
Aluminum arsenate; no spreader......	150	12	96	64.0	21.6
Aluminum arsenate; casein spreader...	100	16	58	58.0	29.0
Basic lead arsenate; no spreader......	150	24	36	24.0	70.6
Basic lead arsenate; casein spreader...	150	33	66	44.0	46.1
Calcium arsenate; no spreader.......	150	6	6	4.0	95.1
Calcium arsenate; casein spreader....	150	18	66	44.0	46.1
Ferric arsenate; no spreader..........	150	21	72	48.0	41.2
Ferric arsenate; casein spreader......	150	3	120	80.0	2.1
Magnesium arsenate; no spreader.....	150	24	102	68.0	16.7
Magnesium arsenate; casein spreader..	150	9	120	80.0	2.1
Manganese arsenate; no spreader.....	150	15	66	44.0	46.1
Manganese arsenate; casein spreader..	150	9	51	54.0	33.9
Paris green; no spreader.............	150	33	6	4.0	95.1
Paris green; casein spreader..........	150	27	10	20.0	75.5
Tricalcium arsenate; no spreader.....	150	36	18	12.0	85.3
Tricalcium arsenate; casein spreader..	150	24	81	54.0	33.9
Zinc arsenate; no spreader...........	150	45	12	8.0	90.2
Zinc arsenate; casein spreader........	150	15	90	60.0	26.5
Zinc arsenite; no spreader...........	150	15	72	48.0	41.2
Zinc arsenite; casein spreader........	150	21	63	42.0	48.6
Barium fluosilicate; no spreader......	200	42	27	13.5	83.4
Barium fluosilicate; casein spreader...	150	27	45	30.0	63.2
Sodium fluosilicate; no spreader......	150	9	42	28.0	65.7
Sodium fluosilicate; casein spreader...	150	31	42	28.0	65.7
Acid lead arsenate ($PbHAsO_4$) no spreader......................	200	46	24	12.0	85.3
Acid lead arsenate ($PbHAsO_4$) casein spreader......................	175	29	84	48.0	41.2

IN AMOUNTS EQUIVALENT TO 2 POUNDS OF LEAD ARSENATE TO 50 GALLONS OF WATER

Material	Number of larvae used	Number of stings	Number of entrances	Per cent entrances	Per cent efficiency
Aluminum arsenate; no spreader	150	33	24	16.0	80.4
Aluminum arsenate; casein spreader	150	9	102	68.0	16.7
Basic lead arsenate; no spreader	150	27	6	4.0	95.1
Basic lead arsenate; casein spreader	150	21	42	28.0	65.7
Calcium arsenate; no spreader	150	39	18	12.0	85.3
Calcium arsenate; casein spreader	150	9	48	32.0	60.8
Ferric arsenate; no spreader	150	15	36	24.0	70.6
Ferric arsenate; casein spreader	150	6	78	52.0	36.3
Magnesium arsenate; no spreader	150	21	54	36.0	55.9
Magnesium arsenate; casein spreader	150	3	102	68.0	16.7
Manganese arsenate; no spreader	150	42	12	8.0	90.2
Manganese arsenate; casein spreader	150	24	24	16.0	80.4
Paris green; no spreader	150	45	0	0.0	100.0
Paris green; casein spreader	150	30	6	4.0	95.1
Tricalcium arsenate; no spreader	150	33	12	8.0	90.2
Tricalcium arsenate; casein spreader	150	9	6	4.0	95.1
Zinc arsenate; no spreader	150	18	30	20.0	75.5
Zinc arsenate; casein spreader	150	12	36	24.0	70.6
Zinc arsenite; no spreader	150	39	0	0.0	100.0
Zinc arsenite; casein spreader	150	27	18	12.0	85.3
Barium fluosilicate; no spreader	150	51	0	0.0	100.0
Barium fluosilicate; casein spreader	150	24	30	20.0	75.5
Acid lead arsenate ($PbHAsO_4$); no spreader	150	24	12	8.0	90.2
Acid lead arsenate ($PbHAsO_4$); casein spreader	150	44	46	30.6	62.5
Unsprayed (checks)	175	0	143	81.7	0.0

RESULTS. As will be noted in Table 1, the following materials were tested with and without calcium caseinate as a spreader: acid lead arsenate, aluminum arsenate, basic lead arsenate, calcium arsenate, ferric arsenate, magnesium arsenate, manganese arsenate, Paris green, tri-calcium arsenate, zinc arsenate, zinc arsenite, barium fluosilicate, and sodium fluosilicate. Each material was tested at the rate equivalent to 1 and 2 pounds of lead arsenate to 50 gallons of water. In the tests where calcium caseinate was employed as a spreader it was used at the recommended rate of one-eighth pound to 50 gallons water. Of the many tests made, those in which calcium caseinate had been added as a spreader to the mixture showed an increase in the percentage of entrances except in four instances. These exceptions were when aluminum arsenate was tested with and without the spreader at the 1-pound rate, zinc arsenate at the 1-pound rate, and tri-calcium arsenate when used at the 2-pound rate.

The data presented in Table 1 also show some materials which are rather high in toxicity. The materials giving the best results when used at the one pound rate are: Paris green, acid lead arsenate, calcium

arsenate, tri-calcium arsenate, barium fluosilicate, and zinc arsenate. Manganese arsenate and basic lead arsenate gave results of promise when the rate of application was increased to 2 pounds to 50 gallons water.

TESTS WITH MISCELLANEOUS CHEMICALS. Two hundred eighty-three materials in this group were tested in the laboratory against the codling moth. The chemicals were chosen with a view to include representative members from as many groups as possible with the definite object of finding some group or groups of compounds which might be useful. It was impossible to obtain members of certain groups, in others, only a few compounds were available. A study of the recent literature reporting work along similar lines revealed that all the work was done with insects other than the codling moth. A study was made of the various chemicals tested and of the insecticidal character of the various groups in so far as the data enabled one to make such a comparison. A list of the various chemical groups was prepared and an attempt was made to obtain several representatives from as many of the groups as possible. It was found impossible to purchase many of the chemicals originally selected for tests. Certain lists of chemicals carried in stock by dealers were then examined and compounds which were similar in character to those originally selected were purchased. The chemicals tested include representatives of as many of the groups as it was possible to obtain under the circumstances.

The materials numbered from 1 to 203, inclusive, in Table 2 were applied as dusts undiluted. The materials numbered from 208 to 280, inclusive, were liquids at ordinary temperatures and were applied by impregnating them in talc at the rate of 5 grams of the material to 45 grams of talc.

TABLE 2. RESULTS OF TESTS OF MISCELLANEOUS CHEMICALS APPLIED AS DUSTS AGAINST THE LARVA OF THE CODLING MOTH, MOORESTOWN, NEW JERSEY 1927 AND 1928

No.	Material	Number of larvae used	Number of stings	Number of entrances	Per cent entrances	Per cent efficiency
1	Acetamide	100	8	56	56.0	31.2
2	Acetanilide	50	1	42	84.0	0.0
3	Acetphenetidin	25	4	16	64.0	21.3
4	Acetyl diphenylamine	25	0	13	52.0	36.1
5	Acetyl p-anisidine	25	2	19	76.0	6.6
6	Acetyl p-aminobenzoic acid	25	0	25	100.0	0.0
7	Acetoxime	100	15	45	45.0	44.7
8	Acetyl-o-methyl toluidine	25	2	21	84.0	0.0
9	Acetyl n-propylaniline	175	19	31	17.7	78.2
10	dl-Alanine	150	7	81	54.0	21.3

TABLE 2.—*Continued*

No.	Material	Number of larvae used	Number of stings	Number of entrances	Per cent entrances	Per cent efficiency
11	Alloxantin	25	3	16	64.0	33.6
12	Allontoin	25	1	20	80.0	1.7
13	Aminoguanidine bicarbonate	25	5	17	68.0	16.4
14	p-Aminobenzoic acid	100	16	58	58.0	28.7
15	p-Aminoazobenzene	100	15	59	59.0	27.5
16	p-Aminophenol	25	5	11	44.0	45.9
17	p-Aminophenol oxalate	25	5	16	64.0	21.3
18	m-Aminophenol	25	2	14	56.0	31.2
19	Anthranilic acid	25	2	14	56.0	31.2
20	Antimony sulphide	150	7	111	74.0	9.0
21	Asparagin	25	0	23	92.0	0.0
22	l-Aspartic acid	25	0	18	72.0	15.5
23	Azobenzene	175	13	23	13.1	83.9
24	Azoxybenzene	175	30	15	8.5	89.5
25	Allyl urea	100	3	50	50.0	38.8
26	Acetoacetanilide	100	0	0	0.0	100.0
27	Barbituric acid	25	1	17	68.0	16.4
28	Barium fluoride	225	19	82	32.0	60.7
29	Barium hydroxide	125	14	75	50.0	38.5
30	Barium carbonate	150	6	78	52.0	36.1
31	Barium fluosilicate	200	13	7	3.5	95.7
32	Berberine bisulphate	150	25	65	42.7	47.4
33	Benzanilide	25	2	12	48.0	41.0
34	Benzeneazo-o-cresol	100	8	25	25.0	69.2
35	Benzenesulfonamide	25	3	19	76.0	6.6
36	Benzamide	100	9	38	38.0	53.3
37	Benzidine	125	10	66	52.8	35.1
38	Benzoyl o-toluidine	25	2	16	64.0	21.3
39	Benzoyl a-naphthylamine	25	4	17	68.0	14.4
40	Bismark brown	25	2	21	84.0	0.0
41	Borax	150	0	72	48.0	41.0
42	Brucine alkaloid	25	1	12	48.0	41.0
43	p-Bromobenzene sulfochloride	25	2	11	44.0	45.9
44	Brilliant green	25	3	13	52.0	36.1
45	n-Butylarsonic acid	100	11	13	13.0	84.0
46	Caffeine	25	1	18	72.0	15.5
47	Calcium borate	150	12	102	68.0	16.4
48	Calcium fluoride	150	9	51	34.0	58.2
49	Carbazole	125	20	23	18.4	77.4
50	Carbanilide	25	3	16	64.0	21.3
51	Cinchonine	25	5	13	52.0	36.1
52	Copper sulfocyanide	200	9	98	49.0	39.8
53	Copper carbonate	225	3	90	40.0	50.8
54	p-Chlorobenzonitrile	25	2	13	52.0	36.1
55	a-Chlorolepidine	100	5	37	37.0	54.5
56	b-Chloronaphthalene	100	10	13	13.0	84.0
57	Crysoidine	25	0	18	72.0	15.5
58	l-Cystine	100	4	53	53.0	34.9
59	Coniine hydrobromide	100	7	61	61.0	25.0
60	Dianisidine	25	0	16	64.0	21.3
61	Diazoaminobenzene	120	0	0	0.0	100.0
62	Dibemzoyl ethylenediamine	100	12	39	39.0	52.0
63	Dibromobarbituric acid	100	8	28	28.0	65.6
64	Dibenzylamine	25	8	12	48.0	41.0
65	Dichlorobarbituric acid	25	2	17	68.0	16.4
66	Dicyandiamidine sulfate	25	1	19	76.0	6.6

TABLE 2.—*Continued*

No.	Material	Number of larvae used	Number of stings	Number of entrances	Per cent entrances	Per cent efficiency
67	Dicyandiamidine	25	0	23	92.0	0.0
68	Dibromonaphthalene	100	24	0	0.0	100.0
69	Diethylbarbituric acid	100	9	32	32.0	60.7
70	p-Dimethylamino-phenol oxalate	100	17	9	9.0	88.9
71	2.4-Dinitrochlorobenzene	100	0	2	2.0	97.5
72	2.4-Dinitrophenol	100	0	0	0.0	100.0
73	3.5-Dinitro-o-cresol	100	0	0	0.0	100.0
74	2.4-Dinitrotoluene	100	4	1	1.0	98.7
75	2.4-Dimitroaniline	100	19	4	4.0	95.0
76	Di-b-naphthylamine	25	3	14	56.0	31.2
77	Dinitroresocinol	25	2	15	60.0	26.2
78	Di-o-nitrophenyl disulfide	25	0	24	96.0	0.0
79	2.6-Dinitro-4-chlorophenol	100	4	1	1.0	98.7
80	o-Dinitrobenzene	25	0	24	96.0	0.0
81	Diphenylpiperazine	100	11	16	16.0	80.3
82	4.4-Diphenylsemicarbazide	25	1	18	72.0	15.5
83	Diphenylformanidine	25	0	13	52.0	36.1
84	Diphenylguanidine	25	0	18	72.0	15.5
85	Diphenylethylenediamine	25	3	11	44.0	45.9
86	Diphenylamine	125	0	1	0.8	99.0
87	Diphenylurethane	100	3	14	14.0	82.8
88	Diphenylpiperzine hydrochloride	25	2	15	60.0	26.2
89	Diphenylcarbamine chloride	125	21	20	16.0	80.3
90	Di-p-toluene sulfamide	25	0	16	64.0	21.3
91	Di-o-tolyguanidine	25	3	11	44.0	45.9
92	Di-o-tolythiourea	100	4	52	52.0	36.1
93	2.5-Dichloroaniline	100	2	60	60.0	26.2
94	Ethylenediamine hydrobromide	25	4	13	52.0	36.1
95	Ethyl p-nitrobenzoate	25	5	14	56.0	31.2
96	Ethyl p-nitrocinnamate	25	2	21	84.0	0.0
97	Ethyl oxanilate	25	2	18	72.0	15.5
98	Formanilide	100	9	39	39.0	52.0
99	Guanidine carbonate	100	10	38	38.0	53.3
100	Guanidine thiocyanate	100	0	1	1.0	98.7
101	Histidine dichloride	25	3	20	80.0	1.7
102	Hydrazine sulfate	25	4	17	68.0	16.1
103	Hydrobenzamide	25	1	23	92.0	0.0
104	p-Hydroxyazobenzene	25	3	11	44.0	45.9
105	8-Hydroxyquinoline	100	4	16	16.0	80.3
106	Lead fluoride	250	8	70	28.0	65.6
107	Lead chromate	125	5	65	52.0	31.6
108	Lead borate	150	11	90	60.0	26.2
109	Lead formate	125	9	20	16.0	80.3
110	Lead oxalate	100	7	18	18.0	77.8
111	Lead salicylate	25	4	15	60.0	26.2
112	Lead thiosulfate	25	2	12	48.0	41.0
113	Magnesium fluoride	200	14	68	34.0	58.2
114	Magnesium borate	150	2	75	50.0	38.5
115	Manganese borate	200	2	58	29.0	64.3
116	Malachite green	100	4	19	19.0	76.6
117	Malonamide	25	1	20	80.0	1.7
118	Mercury sulfocyanate	125	32	2	1.6	98.0
119	Mercuric chloride	250	1	70	28.0	65.6
120	Metanilic acid	25	1	15	60.0	26.2
121	Methyl p-nitrobenzoate	25	3	20	80.0	1.7
122	a-Naphthylamine	100	2	8	8.0	90.1

TABLE 2.—*Continued*

No.	Material	Number of larvae used	Number of stings	Number of entrances	Per cent entrances	Per cent efficiency
123	b-Naphthylamine	25	3	15	60.0	26.2
124	b-Naphthyl salicylate	25	3	11	44.0	45.9
125	Nickel cyanide	125	0	90	72.0	15.5
126	Nickel borate	150	0	51	34.0	58.2
127	m-Nitrobromobenzene	25	4	17	68.0	16.4
128	p-Nitroaniline	125	15	48	38.4	52.8
129	3-Nitro-4-amino phenetole	100	7	44	44.0	45.9
130	3-Nitro-4-amino toluene	100	2	3	3.0	96.3
131	m-Nitroaniline	25	3	11	44.0	45.9
132	p-Nitroacetanilide	25	4	11	44.0	45.9
133	Nicotinic acid hydrochloride	25	0	19	76.0	6.6
134	o-Nitrobromobenzene	25	7	14	56.0	31.2
135	m-Nitrobenzaldehyde	100	9	29	29.0	64.3
136	p-Nitrobromobenzene	100	14	11	11.0	86.4
137	p-Nitrochlorobenzene	100	24	16	16.0	80.3
138	o-Nitrochlorobenzene	100	8	65	65.0	20.1
139	p-Nitrochlorobenzene	100	22	31	31.0	61.9
140	o-Nitrocinnamic acid	25	0	19	76.0	6.6
141	Nitroguanidine	25	2	19	76.0	6.6
142	a-Nitronaphthalene	125	9	1	0.8	99.0
143	Nitronaphthylamine	125	6	0	0.0	100.0
144	p-Nitrophenol	100	1	13	13.0	84.0
145	o-Nitrophenol	25	1	13	52.0	36.1
146	p-Nitrophenylglycine	100	1	69	69.0	15.2
147	6-Nitroquinoline	150	3	22	14.6	82.0
148	Nitrofluorene	100	0	57	57.0	29.9
149	Oxamide	25	0	23	92.0	0.0
150	Oxanilic acid	100	14	60	60.0	26.2
151	Oxanilide	25	1	20	80.0	1.7
152	Parabanic acid	25	0	23	92.0	0.0
153	p-Phenylenediamine	150	19	20	13.3	83.7
154	Phthalimide	100	0	54	54.0	33.6
155	Phenylurea	100	2	58	58.0	28.7
156	dl-Phenylalanine	25	7	13	52.0	36.1
157	Picric acid	100	8	61	61.0	25.0
158	Picramide	25	2	20	80.0	1.7
159	Picramic acid	25	0	15	60.0	26.2
160	Picryl chloride	25	0	23	92.0	0.0
161	Pilocarpine hydrochloride	25	5	11	44.0	45.9
162	Piperazine hydrate	100	9	12	12.0	83.4
163	Piperine	125	22	22	17.2	78.6
164	Potassium methyl xanthate	100	0	1	1.0	98.7
165	Potassium borate	125	5	75	60.0	38.5
166	Quinaldine	100	0	52	52.0	36.1
167	Quinolinic acid	25	0	19	76.0	6.6
168	Quinine alkaloid	25	2	18	72.0	15.5
169	Rosaniline hydrochloride	25	3	18	72.0	15.5
170	Sodium magnesium fluoride	100	4	44	44.0	45.9
171	Sodium fluosilicate	125	10	30	24.0	70.5
172	Sodium p-toluenesulfinate	25	2	22	88.0	0.0
173	Strychnine aklaloid	125	1	48	38.4	52.8
174	Strontium fluoride	200	8	72	36.0	55.7
175	Strontium borate	175	5	112	64.0	21.3
176	Sulfanilic acid	25	1	11	44.0	45.9
177	Tetramethyldiamino benzophenone	25	0	24	96.0	0.0

TABLE 2.—*Continued*

No.	Material	Number of larvae used	Number of stings	Number of entrances	Per cent entrances	Per cent efficiency
178	Tetramethyldiamino benzhydrol.	25	0	20	80.0	1.7
179	Thioacetamide	25	2	13	52.0	36.1
180	Thioacetanilide	100	4	4	4.0	95.0
181	p-Toluenesulfonamide	25	1	14	56.0	31.2
182	p-Toluenesulfonyl - methyl - ptoluidine	25	1	20	80.0	1.7
183	p-Toluenesulfonyl methylaniline.	25	0	21	84.0	0.0
184	p-Toluenesulfonyl-p-toluidine	100	4	47	47.0	42.2
185	p-Toluidine	25	3	19	76.0	6.6
186	Tribenzylamine	25	0	21	84.0	0.0
187	1.3.5-Trinitrobenzene	100	23	28	28.0	65.6
188	Trinitro-m-cresol	125	6	47	37.7	53.6
189	Triphenylguanidine	25	3	16	64.0	21.3
190	Triphenyl phosphine	100	6	15	15.0	81.5
191	Triphenylamine	100	4	58	58.0	28.7
192	Triphenylstibine	100	19	23	23.0	71.7
193	l-Tryosine	25	0	17	68.0	16.4
194	Urethane	25	3	19	76.0	6.6
195	n-Valeramide	100	6	31	31.0	61.9
196	Veratrine alkaloid	125	0	0	0.0	100.0
197	Zinc borate	175	2	77	44.0	45.9
198	Zinc cyanide	125	15	110	88.0	0.0
199	Zinc carbonate	200	6	92	46.0	43.4
200	Zinc fluoborate—Zinc oxide	25	1	8	32.0	60.7
201	Zinc oxalate	25	1	14	56.0	31.2
202	Zinc salicylate	50	3	13	26.0	68.0
203	Zinc sulfate	150	10	96	64.0	21.2
204	Acid lead arsenate	400	21	11	2.75	96.6
205	Checks	2,875	25	2,351	81.4	—
206	Acid lead arsenate 2–50	150	24	12	8.0	90.1
207	Acid lead arsenate 1–50	200	40	24	12.0	85.2
208	Acetate, Iso-amyl	100	13	36	36.0	55.7
209	Acetonitrile	100	3	44	44.0	45.9
210	Acetodichlorohydrin	25	3	13	52.0	36.1
211	Acetophenone	25	3	12	48.0	41.0
212	Alcohol, Iso-amyl	25	2	12	48.0	41.0
213	2-Amino-1.3-dimethylbenzene	175	19	53	30.2	62.9
214	n-Amylamine	175	7	80	45.7	43.8
215	Anisaldehyde	175	10	68	38.8	52.4
216	o-Anisidine	100	3	49	49.0	39.8
217	Benzonitrile	125	11	80	64.0	21.3
218	Benzoyl piperidine	100	3	23	23.0	71.7
219	Benzylamine	100	9	22	22.0	72.9
220	Benzylmethylamine	25	0	17	68.0	16.4
221	n-Butyl acetate	100	1	30	30.0	63.1
222	n-Butyl chlorocarbonate	100	7	40	40.0	50.8
223	di-n-Butylcyanamide	100	23	4	4.0	95.0
224	n-Butyl oxalate	25	1	23	92.0	0.0
225	n-Butyl thiocyanate	100	2	44	44.0	45.9
226	b-Chloroethyl-p-toluene sulfonate	100	1	2	2.0	97.5
227	a-Chloronaphthalene	100	6	31	31.0	61.9
228	Chloropicrin	100	1	31	31.0	61.9
229	o-Cresyl benzoate	100	2	15	15.0	81.5

TABLE 2.—*Concluded*

No.	Material	Number of larvae used	Number of stings	Number of entrances	Per cent entrances	Per cent efficiency
230	Cumidine	125	5	60	48.0	41.0
231	Cyanamide	100	4	3	3.0	96.3
232	Dibenzylamine	100	8	2	2.0	97.5
233	b.b'-Dichloroethyl carbonate	100	3	49	49.0	39.8
234	Dimethylaniline	100	13	36	36.0	55.7
235	Diethylaniline	115	15	40	26.6	67.3
236	Diethyl-o-toluidine	100	6	56	56.0	31.2
237	Dihydronaphthalene	100	8	49	49.0	39.8
238	Diethylamine	100	0	40	40.0	50.8
239	Discard oil (from bone oil)	175	9	46	26.2	67.8
240	Ethyl benzyl o-toluidine	125	10	6	4.8	94.3
241	Ethylaniline	25	5	12	48.0	41.0
242	Ethylamine	25	4	14	56.0	31.2
243	Ethylene cyanide	125	4	41	32.8	59.7
244	Ethyl cyamoacetate	100	1	52	52.0	31.6
245	Ethyl isothiocyanate	100	3	38	38.0	53.3
246	Ethyl methyl xanthate	25	2	13	52.0	31.6
247	Ethyl-a-naphthylamine	100	20	4	4.0	95.0
248	Ethyl thiocyanate	125	8	51	40.8	49.8
249	Iso-amylaniline	100	2	15	15.0	81.1
250	Iso-amyl chlorocarbonate	100	2	39	39.0	52.0
251	Iso-amyl formate	100	0	34	34.0	58.2
252	Iso-amyl nitrate	100	3	20	20.0	75.4
253	Iso-amyl nitrite	100	3	49	49.0	39.8
254	Iso-amyl oxalate	100	3	51	51.0	37.3
255	Iso-amyl phthalate	100	2	40	40.0	50.8
256	Iso-butyl n-butyrate	25	2	11	44.0	45.9
257	Iso-Propyl oxalate	100	3	32	32.0	60.7
258	Methylaniline	100	2	34	34.0	58.2
259	Methyl carbonate	100	1	22	22.0	72.9
260	Methyldiphenylamine	25	7	11	44.0	45.9
261	Methyl-a-naphthylamine	100	2	7	7.0	91.4
262	Nicotine	225	7	0	0.0	100.0
263	Nitrobenzene	100	25	34	34.0	58.2
264	Nitromethane	100	4	39	39.0	52.0
265	o-Nitrotoluene	100	3	12	12.0	85.2
266	Pentamethylene bromide	25	1	14	56.0	31.2
267	p-Phenetidine	25	4	12	48.0	41.0
268	Phenyl isocyanide	100	4	42	42.0	48.5
269	a-Picoline	100	2	29	29.0	64.3
270	Piperidine	100	6	19	19.0	76.6
271	n-Propyl p-toluene sulfonate	100	0	5	5.0	93.8
272	Pyridine	100	4	31	31.0	61.9
273	Quassia extract	100	1	50	50.0	38.8
274	Quinoline	225	21	59	22.6	72.2
275	Tetraethylammonium hydroxide	100	1	65	65.0	20.1
276	Tetramethylammonium hydroxide	100	14	16	16.0	80.3
277	p-Toluenesulphonyl-p-toluidine	100	8	32	32.0	60.7
278	Triethylamine	100	3	42	42.0	48.5
279	Trimethylamine	100	2	52	52.0	31.6
280	Tri-iso-amylamine	25	2	12	48.0	41.0
281	Talc (alone)	300	2	223	74.3	8.7

Results

From the data presented in Table 2 it will be noted that many of the materials tested gave a high percentage of efficiency. Those materials which gave promising results when used undiluted were selected for further tests. The materials were divided into two groups, namely, liquids and powders. They are listed in Table 3 as follows: Numbers 1 to 36, inclusive, were powders and were diluted with talc at the rate of 5 grams of the material to 45 grams of talc, or a 10 per cent dust. Those materials listed under numbers 37 to 60, inclusive, were liquids at ordinary temperatures and were diluted with talc and applied as dusts at the rate of 5 grams of the material in 45 grams of talc.

Table 3. Results of Tests of Miscellaneous Chemicals Applied as 10 per cent Dusts Against the Larva of the Codling Moth, Moorestown, New Jersey, 1928

No.	Material	Number of larvae used	Number of stings	Number of entrances	Per cent entrances	Per cent efficiency
1	Azobenzene	200	8	37	37.0	77.7
2	Azoxybenzene	200	0	86	43.0	48.3
3	Acetyl n-propylaniline	100	4	24	24.0	71.1
4	n-Butylarsonic acid	175	5	19	10.8	87.0
5	Benzamide	175	5	43	24.6	70.4
6	Benzeneazo-o-cresol	175	3	66	37.7	54.7
7	Carbazole	275	15	68	24.7	70.4
8	b-Chloronaphthalene	175	4	92	52.5	36.9
9	Dibromonaphthalene	150	4	24	16.0	80.7
10	Diphenylcarbamine chloride	275	12	53	30.2	63.7
11	2.6 Dinitro-4-chlorophenol	275	10	68	24.7	70.4
12	Diphenylurethane	275	10	41	14.9	82.1
13	Dimethylamino phenol oxalate	275	1	47	17.0	79.6
14	Diphenylpiperazine	75	0	45	59.9	28.0
15	Diazoaminobenzene	275	5	106	38.5	53.7
16	Dibromobarbituric acid	275	3	58	21.0	74.7
17	2.4-Dinitroaniline	175	1	68	38.5	53.7
18	Diphenylamine	275	1	9	3.2	96.1
19	2.4-Dinitrochlorobenzene	175	20	60	34.2	58.9
20	2.4-Dinitrotoluene	75	0	1	1.3	98.4
21	2.4-Dinitrophenol	75	0	0	0.0	100.0
22	3.5-Dinitro-o-cresol	75	0	0	0.0	100.0
23	8-Hydroxyquinoline	175	1	98	56.0	32.7
24	Lead formate	175	3	106	62.8	24.6
25	Mercury sulfocyanate	175	32	26	14.8	82.2
26	Malachite green	75	8	17	22.6	72.8
27	p-Nitrochlorobenzene	265	36	60	22.6	72.8
28	a-Naphthylamine	75	0	0	0.0	100.0
29	6-Nitroquinoline	275	23	99	36.0	68.7
30	a-Nitronaphthalene	275	21	24	87.3	0.0
31	3-Nitro-4-amino-toluene	175	3	86	49.1	39.8
32	Nitronaphthylamine	175	14	34	19.4	76.7
33	m-Nitrobenzaldehyde	175	11	66	37.7	54.7
34	Triphenylamine	100	19	30	30.0	63.9
35	n-Valeramide	275	0	130	47.2	43.3
36	Veratrine alkaloid	75	0	7	9.3	88.8

TABLE 3.—*Continued*

No.	Material	Number of larvae used	Number of stings	Number of entrances	Per cent entrances	Per cent efficiency
37	Anisaldehyde	100	5	23	23.0	72.3
38	n-Amylamine	100	3	18	18.0	77.9
39	2-Amino-1.3-dimethylbenzene	100	0	40	40.0	51.9
40	Benzylamine	175	0	82	46.6	46.2
41	n-Butyl acetate	175	5	57	32.6	60.8
42	di-n-Butyl cyanamide	175	26	41	23.4	71.5
43	Benzoyl piperidine	175	5	37	21.1	74.2
44	n-Butyl thiocyanate	175	2	103	58.9	29.3
45	b-Chloroethyl-p-toluene sulfonate	170	0	0	0.0	100.0
46	a-Chloronaphthalene	275	14	159	57.9	30.5
47	o-Cresyl benzoate	175	5	52	29.7	64.3
48	Diethylaniline	175	0	106	60.6	27.2
49	Disacrd oil (from bone oil)	100	6	27	27.0	67.5
50	Ethyl a-naphthylamine	175	11	32	18.3	77.8
51	Ethyl benzyl o-toluidine	175	9	35	20.0	75.9
52	Methyl carbonate	175	4	54	30.8	64.6
53	Methyl a-naphthylamine	175	6	76	43.4	47.9
54	o-Nitrotoluene	175	0	130	74.4	10.7
55	Pyridine	175	1	86	49.2	40.9
56	a-Picoline	175	4	92	52.6	36.8
57	Piperidine	100	0	39	39.0	53.1
58	Quinoline	175	5	80	45.7	45.1
59	Tetraethylammonium hydroxide	175	1	103	58.9	29.2
60	Tetramethylammonium hydroxide	100	6	33	33.0	60.4
61	Acid lead arsenate (Dust)	175	7	2	1.1	98.6
62	Checks	1,775	17	1,480	83.38	—
63	Quinoline emulsion (10)	200	10	128	64.0	23.1
64	a-Chloronaphthalene emulsion (10)	100	4	36	36.0	68.7

RESULTS. The most effective materials tested against the codling moth are listed below. Only those materials whose per cent efficiency is 70 or more are given. The values of these materials are taken from Table 2 and not Table 3. It should be distinctly understood that these materials have not been tested under a wide range of conditions. Further tests will be necessary to determine if any of them can be used in a practical way under field or orchard conditions.

Although the records are not complete owing to the authors having been transferred to other work, it is hoped that the data reported herein will form a basis for a continuation of this search for a practical arsenical substitute.

TABLE 4. THE MOST EFFECTIVE MATERIALS TESTED AGAINST LARVAE OF THE CODLING MOTH AS SUBSTITUTES FOR LEAD ARSENATE

Material	Per cent of efficiency
Acetyl n-propylaniline	78.2
Azobenzene	83.9
Azoxybenzene	89.5
Acetoacetanilide	100.0

TABLE 4.—*Continued*

Material	Per cent of efficiency
Barium fluosilicate	95.7
n-Butylarsonic acid	84.0
Carbazole	77.4
b-Chloronaphthalene	84.0
Diazoaminobenzene	100.0
Dibromonaphthalene	100.0
p-Dimethylamino phenol oxalate	88.9
2.4-Dinitrochlorobenzene	97.5
2.4-Dinitrophenol	100.0
3.5-Dinitro-o-cresol	100.0
2.4-Dinitrotoluene	98.7
2.4-Dinitroaniline	95.0
2.6-Dinitro-4-chlorophenol	98.7
Diphenylpiperazine	80.3
Diphenylamine	99.0
Diphenylurethane	82.8
Diphenylcarbamine chloride	80.3
Fluoricide (7.5)	72.9
Guanidine thiocyanate	98.7
8-Hydroxyquinoline	80.3
Lead formate	80.3
Lead oxalate	77.8
Malachite green	76.6
Mercury sulfocyanate	98.0
a-Naphthylamine	90.1
3-Nitro-4-amino toluene	96.3
m-Nitrobenzaldehyde	86.4
p-Nitrobromobenzene	80.3
a-Nitronaphthalene	99.0
Nitronaphthylamine	100.0
p-Nitrophenol	84.0
6-Nitroquinoline	82.0
p-Phenylenediamine	83.7
Piperazine hydrate	83.4
Piperine	78.6
Potassium methyl xanthate	98.7
Sodium fluosilicate	70.5
Thioacetanilide	95.0
Triphenyl phosphine	81.5
Triphenylstibine	71.7
Veratrine alkaloid	100.0
Benzoyl piperidine	71.7
Benzylamine	72.9
di-n-Butylcyanamide	95.0
b-Chloroethyl-p-toluene sulfonate	97.5
o-Cresyl benzoate	81.5
Cyanamide	96.3
Dibenzylamine	97.5
Ethyl benzyl o-toluidine	94.3
Ethyl-a-naphthylamine	95.0
Iso-amylaniline	81.1
Iso-amyl nitrate	75.4
Methyl carbonate	72.9
Methyl-a-naphthylamine	91.4
Nicotine (95)	100.0
o-Nitrotoluene	85.2
Piperidine	76.6
n-Propyl p-toluene sulfonate	93.8
Quinoline	72.2
Tetramethylammonium hydroxide	80.3

SUMMARY. In an investigation having as its object the discovery of a poison for codling moth control suitable for application in place of lead arsenate, many organic compounds were tested. A total of 283 materials other than lead arsenate are reported in this paper.

The tests were made by thoroughly applying the material to apples on which newly hatched codling moth larvae were placed. The coating of the material on the apple was of such a nature that the insect was unable to reach any portion of the apple without first going through the poison coat. A total of 46,960 newly hatched larvae were used in conducting the tests.

About 50 of all the materials tested as arsenical substitutes show an efficiency of 70 per cent or better and have been selected as worthy of further trial.

No attempt has been made to utilize any of these materials mentioned in the above paragraph in a practical way. The results herein reported deal strictly with the effectiveness of the compounds and mixtures tested for preventing entrance of codling moth larvae into treated apples under the conditions of the experiments.

LITERATURE CITED

1. ABBOTT, W. S. 1925. A Method of Computing the Effectiveness of an Insecticide. Jour. Econ. Ent. 18: 265–267.
2. LOVETT, A. L., and ROBINSON, R. H. 1917. Toxic Values and Killing Efficiency of the Arsenates. Jour. Agr. Res. 10: 199–207.
3. NEWCOMER, E. J. 1923. Codling Moth Control in Washington. Wash. State Hort. Proc. (1922) 18: 39–44.
4. NEWCOMER, E. J. 1926. Laboratory Experiments with Arsenicals in the Control of the Codling Moth. Jour. Agr. Res. 33: 317–330.
5. SMITH, R. H. 1926. The Efficacy of Lead Arsenate in Controlling the Codling Moth. "Hilgardia," Cal. Agr. Exp. Sta., Vol. 1, No. 17.
6. STEARNS, L. A., and HOUGH, W. S. 1923. Spreader Tests on Apples and Peaches. Jour. Econ. Ent. 16: 198–201.

FURTHER RESULTS WITH TRAP BAITS FOR CAPTURING THE CODLING MOTH[1]

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ABSTRACT

The fifth year's tests were made in 1928 with trap baits for capturing the codling moth, *Carpocapsa pomonella* L. A severely infested orchard was used this season. Comparisons of various baits and their dilutions were made, and the use of bread and wild yeasts for starting fermentation, and of boric acid for preventing it. A comprehensive test made to determine the most efficient number of traps showed that the number of moths captured per trap increased with the number of trees from which moths could be attracted, but not in direct ratio.

Experiments with trap baits for capturing the codling moth in 1928 were conducted in four different orchards, but for the purposes of this paper the results in only one, the A. B. Haueter orchard, are discussed.

The Haueter orchard consisted of 5 acres of large, 30-year-old apple trees of several varieties. The tract had been neglected not only in 1928 but in previous seasons so the accumulated infestation was un-

TABLE 1. NUMBER OF CODLING MOTHS CAPTURED IN TRAP BAITS, HAUETER ORCHARD, YAKIMA, WASH., 1928; TEST NO. 1 (JULY 24–AUGUST 17)

Material	Total number of moths in— Dilution 1–10	Total number of moths in— Dilution 1–20	Average number of moths per trap-day in— Dilution 1–10	Average number of moths per trap-day in— Dilution 1–20
Malt syrup+bread yeast, 10 traps	1,594	1,460	13.28	12.17
Malt syrup+wild yeast, 10 traps	971	846	8.09	7.05
Cane molasses+bread yeast, 10 traps	1,793	1,394	14.94	11.62
Cane molasses+wild yeast, 10 traps	1,661	1,030	13.84	8.58
Beet molasses+bread yeast, 10 traps	855	931	7.13	7.76
Beet molasses+wild yeast, 10 traps	1,759	984	14.66	8.20
Cane molasses+boric acid, ¾ lb. per 10 qts. of bait, 10 traps	487	129	4.06	1.08
Beet molasses+boric acid, ¾ lb. per 10 qts. of bait, 10 traps	909	368	7.58	3.07

Material	Total number of moths	Average number of moths per trap-day
Apple ferment containing ¾ lb. brown sugar to 3 gallons of diluted apple juice, 10 traps	1,720	7.17
Brown sugar ¾ lb. to 3 gallons of water, 10 traps	2,007	8.36
Brown sugar ¾ lb. to 3 gallons water+geraniol 20 drops to a qt., 9 traps	2,759	12.76
Beet molasses 1–10 (check), 7 traps	1,146	6.82
Cane molasses 1–10 (check), 4 traps	1,134	11.81

[1]Yothers, M. A. Summary of Three Years' Tests of Trap Baits for Capturing the Codling Moth. JOUR. ECON. ENT. 20, p. 567, 1927.

Yothers, M. A. Summary of Results Obtained with Trap Baits in Capturing the Codling Moth in 1927. JOUR. ECON. ENT. 23, p. 576, 1930.

usually severe. This season the trees had been sprayed a couple of times, in an indifferent manner, for the spring brood only, consequently a great many moths were present when the traps were installed July 24.

Each trap in this test consisted of a 3-pint enameled kettle suspended by a seine cord run through a screw eye inserted in a cross arm at the top of a tree prop in the center of a tree. Ten rows of 13 to 14 trees each had a trap in each tree; beyond that traps were placed in every alternate tree in rows 11, 12, 14, 18, 21, 24, and 25. A total of 171 traps were operated from July 24 to September 6, and 143 from that date to September 14.

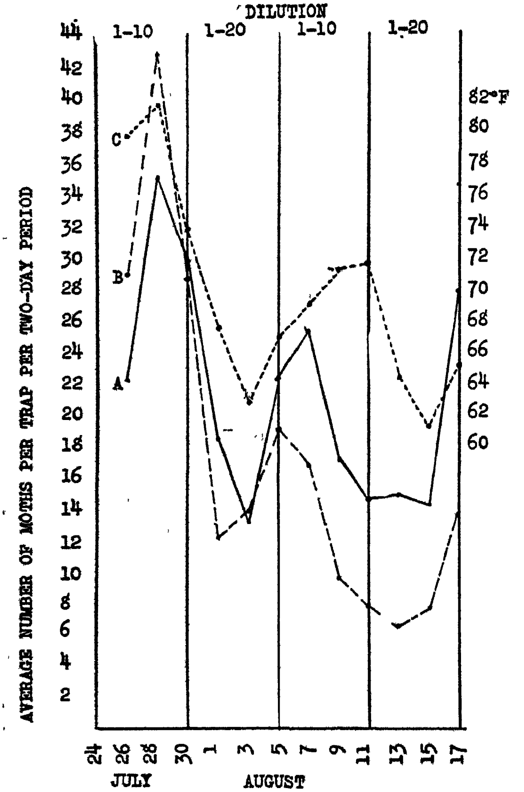

FIG. 73.—A comparison of dilutions of 1–10 and 1–20 of several kinds of codling moth baits, and the relation of temperature to the number of moths captured. A, Malt syrup, cane molasses, and beet molasses, each with bread and wild yeast added (grouped together); B, combined checks of constant 1-10 dilutions of cane molasses and beet molasses; C, average mean temperature from 6 P. M. to 12 midnight for the two days preceding date of record.

In Test No. 1 ten traps, one to a tree, were used for each material except the brown sugar+geraniol which had 9, and the checks, which had 7 for the beet molasses and 4 for the cane molasses. The test ran from July 24 to August 17. The bait materials in the first group were diluted 1 part to 10 parts of water for the first 6-day period, 1–20 for the second 6-day period, 1–10 again for the third, and 1–20 again for the fourth period. Malt syrup, cane molasses, and beet molasses, each with bread and wild yeast added, and cane molasses and beet molasses

each with boric acid added to prevent fermentation, were compared. A dilution of 1–20 in every case but one (beet molasses + bread yeast) was apparently less effective than a dilution of 1–10; however, this difference is largely minimized by corresponding variations in temperature (Fig. 73) in each of the 6-day periods. Concurrent comparisons of dilutions of these and other baits, however, indicate that the 1–10 dilution was usually somewhat more efficient than any greater dilution. From a comparison of these bait materials—malt syrup, cane molasses, and beet molasses—there appeared to be but little difference in their attractive value. Malt syrup appeared to be more attractive when bread yeast was added than when wild yeast[2] was added, whereas cane

TABLE 2. NUMBER OF CODLING MOTHS CAPTURED IN TRAP BAITS, HAUETER ORCHARD, YAKIMA, WASH., 1928; TEST NO. 2 (AUGUST 17, 1929)

Material and dilution	Total number of moths in— Dilution 1–10	Total number of moths in— Dilution 1–20	Average number of moths per trap-day in— Dilution 1–10	Average number of moths per trap-day in— Dilution 1–20
Beet molasses+bread yeast left from previous tests, 10 traps	707	356	11.78	5.93
Malt syrup+bread yeast left from previous tests, 10 traps	970	517	16.17	8.62
Cane molasses+bread yeast left from previous tests, 10 traps	748	353	12.47	5.89
Beet molasses+wild yeast, 10 traps	443	282	7.38	4.70
Cáne molasses+wild yeast, 10 traps	469	306	7.82	5.10
Beet molasses (check) 1–10, 7 traps	448	204	10.67	4.86
Cane molasses (check) 1–10, 4 traps	313	135	13.04	5.63

	Total number of moths	Average number of moths per trap-day
Geraniol and water, 20 drops to a qt., 10 traps	131	2.18
Geraniol and beet molasses, 20 drops to a qt., 10 traps	380	6.33
Geraniol and cane molasses, 20 drops to a qt., 10 traps	312	5.20
Geraniol and brown sugar, ¾ lb. to 3 gallons, 10 traps	319	5.32
Brown sugar, ¾ lb. to 3 gallons, 10 traps	375	6.25
Apple ferment 1 to 3 parts of water, 9 traps	138	2.56
Brown sugar, 1½ lbs. to 10 qts. water, 10 traps	234	3.90
Geraniol and brown sugar, 10 traps	377	6.28
Beet molasses 1–5, 10 traps	194	3.23
Malt syrup 1–32, 10 traps	210	3.50
Apple ferment 1 to 2 parts of water, 9 traps	146	2.70
One-half apple floated in water, 5 traps	6	.30
One-half apple floated in brown sugar (1 lb. to 5 qts.), 5 traps	61	3.05

[2]These wild yeasts were produced from spontaneous fermentation in tests in another orchard and brought over for use here by C. R. Gross of the Bureau of Chemistry.

molasses was apparently about as effective with one as with the other, but beet molasses was more attractive when it was inoculated with wild yeast than when bread yeast was added. The addition of boric acid to cane and beet molasses to prevent fermentation prevented a great many moths from entering these baits, but considerable numbers were caught nevertheless.

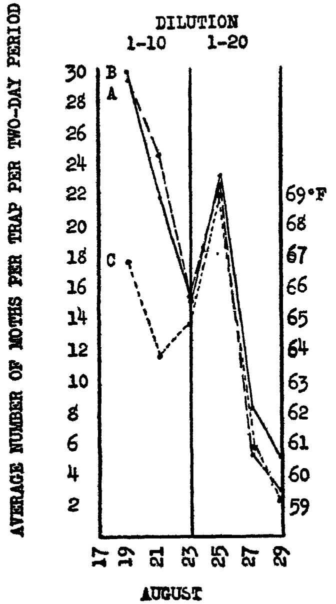

FIG. 74.—A comparison of dilutions of 1–10 and 1–20 of several kinds of codling moth trap baits, and the relation of temperature to the number of moths captured. A, Malt syrup, cane molasses, and beet molasses each with bread yeast and wild yeast added (grouped together); B, combined checks of constant 1–10 dilutions of cane molasses; C, average mean temperature from 6 P. M. to 12 midnight for the two days preceding the date of record.

In this same test additional materials were compared, all of which were comparable with one another and with those of the first group. Apple ferment, brown sugar, and brown sugar + geraniol were compared with two checks consisting of 7 traps of beet molasses and 4 traps of cane molasses, both of which were renewed with new bait every two days throughout the season. Apple ferment, made with ¾ lb. of brown sugar to 3 gallons of diluted apple juice, caught fewer moths than did the same quantity of brown sugar to 3 gallons of water containing no apple juice. The addition of geraniol to brown sugar increased its attractiveness over 50 per cent. The beet molasses check averaged 6.82 moths per trap-day while the cane molasses averaged 11.81.

In Test No. 2, a comparison of beet molasses, malt syrup, and cane molasses each with bread yeast left in the traps from previous tests, the malt syrup was the most effective, cane molasses next, and the best molasses last, but the difference was not significant. The test ran from August 17 to August 29, a 6-day period for each dilution, as in Test No, 1, for the first two groups, a 6-day period for the third and fourth groups. and a 4-day period for the last group. Again the 1–20 dilution seemed to be less attractive, but reference to Figure 74 shows that there is a

corresponding decrease in temperature which greatly counteracts this difference. Cane molasses and beet molasses with bread yeast added caught far more moths than where chance inoculation by wild yeast was depended upon. Both cane molasses and beet molasses caught fewer moths with chance inoculation by wild yeast than these two materials did in the checks where bread yeast was accumulating indefinitely. In additional tests, which are not comparable with the rest of the table, geraniol was found the least effective when added to water only, and most effective when added to beet molasses or brown sugar and water. Comparing brown sugar, brown sugar and geraniol, beet molasses 1–5, malt syrup 1–32, apple ferment, one-half apple floated in water, and one-half of an apple floated in brown sugar and water, the half apple floated in water was the least effective, capturing only 6 moths.

TABLE 3. NUMBER OF CODLING MOTHS CAPTURED IN TRAP BAITS, HAUETER ORCHARD, YAKIMA, WASH., 1928; TEST NO. 3 (AUGUST 29–SEPTEMBER 4)

Material	Dilution	Total number of moths	Average number of moths per trap-day
Apple ferment+new yeast and 1 lb. brown sugar to 3 gallons (10 traps)	—	407	6.78
Brown sugar, 1 lb. to 10 qts. water (10 traps)	—	485	8.08
Geraniol+brown sugar, 1 lb. to 10 qts. water (10 traps)	20 drops per qt. of water	528	8.80
Beet molasses, wild yeast retained (10 traps)	1–10	398	6.63
Cane molasses, wild yeast retained (10 traps)	1–10	509	8.48
Beet molasses+bread yeast (10 traps)	1–10	275	4.58
Malt syrup+bread yeast (10 traps)	1–10	313	5.22
Cane molasses+bread yeast (10 traps)	1–10	302	5.03
Beet molasses+bread yeast (10 traps)	1–5	303	5.05
Cane molasses+bread yeast (10 traps)	1–30	169	2.82
Check. Beet molasses (7 traps)	1–10	174	4.14
Check. Cane molasses (4 traps)	1–10	155	6.46

In another series of tests the most attractive bait of all was the brown sugar and geraniol combination, which captured an average of 8.80 moths per trap-day, while brown sugar alone caught an average of 8.08, and apple ferment, 6.78. Cane molasses, with wild yeast retained in the trap, averaged 8.48 moths per trap-day compared with an average of 6.63 for the beet molasses, also with wild yeast. Malt syrup, cane molasses, and beet molasses with bread yeast added, averaged respectively, 5.22, 5.03 and 4.58 moths per trap-day. Beet molasses 1–5 caught a few more moths than at the regular 1–10 dilution, whereas cane molasses 1–30 caught only an average of 2.82 moths per trap-day compared with 5.03 at the 1–10 strength.

A test was made to determine the most efficient number of traps. (Table 4.) It was found that the catch per trap increased with the

number of trees from which moths could be attracted, but not in direct ratio. Seven traps in 7 trees averaged 6.28 moths per trap-day for 46 days, 7 traps in 13 trees (2 cases) averaged 12.17 and 13.66 respectively, and 6 or 7 traps to 26 to 40 trees in rows 18 to 24 averaged about 23 + moths per trap-day. Seven traps in 13 trees in the last, outside row, averaged 36.65 moths, or about 3 times as many as were caught in row 10 with the same number of traps and trees. This was probably largely due to the fact that more moths are almost invariably captured in outside rows of baited plats. Judging from this test alone, and aside from the matter of expense, in order to secure the maximum catch per trap, one should allow not more than two trees per trap.

That great numbers of codling moths can be captured in trap baits in severely infested orchards is indicated in Table 5, which shows that 91,836 moths were captured in less than 171 traps from July 24 to September 14.

TABLE 4. NUMBER OF CODLING MOTHS CAPTURED IN TRAP BAITS WITH VARYING NUMBERS OF TREES ADJACENT FROM WHICH TO DRAW; HAUETER ORCHARD, YAKIMA, WASH., 1928

Row No.	Number of codling moths captured	Number of traps	Number of trees adjacent	Average number of moths per trap-day for 46 days	Remarks
9	2,023	7	7	6.28	Center of orchard
10	3,920	7	13	12.17	
11	4,400	7	13	13.66	
12	5,109	7	19	15.87	
14	5,215	6	31	18.89	
18	7,608	7	40	23.63	Rows 19 to
21	6,472	6	40	23.45	24 very
24	6,447	6	26	23.36	light crop
25	11,801	7	13	36.65	Outside row

TABLE 5. NUMBER OF CODLING MOTHS CAPTURED IN TRAP BAITS; HAUETER ORCHARD, YAKIMA, WASH., 1928

Date	Number of moths	Date	Number of moths
July 26	5,738	Aug. 21	5,171
28	7,191	23	3,644
30	6,592	25	5,158
Aug. 1	3,101	27	2,101
3	2,194	29	1,126
5	4,459	31	2,294
7	5,305	Sept. 2	3,216
9	5,178	4	3,200
11	3,865	6	2,078[1]
13	3,005	8	492
15	3,194	10	793
17	5,661	12	470
19	6,588	14	22
Total			91,836

[1]171 bait pots used in this and all preceding counts; 143 thereafter.

That large numbers of moths may be caught in single traps is indicated in Table 6, which shows that 3,111 moths were caught in a single trap during the 42 nights from July 24 to September 3 inclusive. This trap was at the corner of the experimental tract, but with another orchard adjoining on one side.

TABLE 6. RECORD OF A SINGLE TRAP CAPTURING THE LARGEST KNOWN NUMBER OF CODLING MOTHS; HAUETER ORCHARD, YAKIMA, WASH., 1928
(Trap No. 7, Row 25)

Date	Number of moths captured
July 26	60
28	131
30	205
Aug. 1	130
3	53
5	180
7	201
9	216
11	218
13	145
15	175
17	130
19	237
21	276
23	160
25	200
27	93
29	21
31	53
Sept. 2	85
4	142
Total	3,111
Number of nights	42
Average number of moths per night	74.07

SUMMARY

Of the several kinds of baits compared, malt syrup, cane molasses, beet molasses, and brown sugar and geraniol were the more promising.

Dilutions of 1–10 are probably only slightly more efficient for most of these baits than dilutions of 1–20.

Variations in temperature had greater effect upon the number of moths captured than the dilution of materials had.

Geraniol added to brown sugar and water and to beet molasses increased their effectiveness.

In a comparison of the effectiveness of bread yeast with wild yeast added to baits, the results were too variable to warrant conclusions one way or another.

The catch of moths per trap increased with the number of trees available from which to attract them, but not in direct ratio.

Great numbers of moths can be captured with bait traps in badly infested orchards.

A COMPARISON OF UNTREATED BANDING MATERIALS FOR CAPTURING CODLING MOTH LARVAE

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ABSTRACT

In comparative tests of several kinds of untreated bands for capturing the larvae of the codling moth (*Carpocapsa pomonella* L.) at Yakima, Wash., a paper-burlap band proved equal or superior to one of burlap, which is customarily used, and is much less expensive. Heavy roofing paper and light crêpe paper were the least effective of the banding materials.

In an unsprayed block in 1927, bands averaged from 167 to 258 larvae per band for the season. In 1928 in another unsprayed orchard, bands averaged from 336 to 1,322 larvae per band for the period July 10 to November 14.

In 1927 and 1928 tests were made to determine the relative efficiency of several kinds of untreated bands for trapping codling moth larvae on the trunks of apple trees.

Description of Materials. Three-ply burlap bands were made by folding single-thickness burlap 1 foot in width twice, making a three-ply burlap band 4 inches wide. Single thickness burlap 8 inches wide was folded once, making a 2-ply band 4 inches in width. In one test the 2-ply burlap was 6 inches wide after folding. A commercial material was used which had been made by fastening together a layer of tough paper and a layer of thin burlap with a light—and water proof coating between them. This was used 8 and 4 inches wide, single thickness, and 4 and 2 inches wide after folding to two thicknesses. The crêpe paper, of medium weight and light color, was cut 4 inches wide and was applied as a single thickness. The roofing paper was a heavy grade of asphalt paper, 4 inches wide and so stiff that it was impossible to fit it snugly to trunks presenting appreciable irregularities.

All bands of more than a single thickness were applied with the open edge down.

Siegert Orchard, 1927. A severely infested unsprayed block of 58 Winesap trees was banded on June 23, 1927. The trees were more or less stunted in growth and ranged in size of trunk from about 6 to 12 inches in diameter. The crop of apples on the trees ranged from one-half bushel to about 15 bushels, none of which, however, was harvested on account of almost total infestation. The trunks were scraped and all of the rough bark removed before the bands were applied. The 58 trees consisted of 8 rows of from 7 to 8 trees each.

The season's experiment was divided into two series of tests, one running from June 23 to Sept. 7, and the other from Sept. 7 to Oct. 28.

The difference between the two tests was that the location of the kinds of bands was changed as to their position in the orchard. This shift was made for the purpose of reducing the influence of all variables as far as possible.

In Table 1 is shown the average number of larvae captured per band and the ranking according to effectiveness regardless of several variable factors. From one to three trees in each row in all but two of the rows, caught so few larvae that they should probably not be averaged in with the others, but since no record of size of crop on these trees was made, they have not been eliminated as aberrant.

TABLE 1. NUMBER OF CODLING MOTH LARVAE CAPTURED UNDER UNTREATED BANDS. SIEGERT ORCHARD. YAKIMA, WASH., 1927

Plat	Material	No. trees	No. larvae caught	Average No. of larvae per band	Rank
	Test I (June 23–Sept. 7)				
A	8-inch paper-burlap, single thickness*	7	1,300	186	6
B	4-inch paper-burlap, 2-ply	8	1,969	246	2
C	4-inch paper-burlap, single thickness	7	1,683	240	3
D	2-inch paper-burlap, 2-ply	8	1,496	187	5
E	4-inch crêpe paper, single thickness	7	1,119	160	7
F	4-inch roofing paper, single thickness	7	963	138	8
G	4-inch burlap, 3-ply	7	2,115	302	1
H	4-inch burlap, 2-ply	7	1,618	231	4
	Total	58	12,263		
	Test II (Sept. 7–Oct. 28)				
H	4-inch burlap, 2-ply	7	985	141	8
G	4-inch burlap, 3-ply	8	1,715	214	4
F	4-inch roofing paper, single thickness	7	1,367	195	6
E	4-inch crêpe paper, single thickness	8	1,605	201	5
D	2-inch paper-burlap, 2-ply	7	1,345	192	7
C	4-inch paper-burlap, single thickness	7	1,629	232	3
B	4-inch paper-burlap, 2-ply	7	1,748	250	2
A	8-inch paper-burlap, single thickness	7	2,235	319	1
	Total	58	12,629		

*In Figure 75, for convenience in labeling, single thickness is designated as "flat."

DISCUSSION OF RESULTS. In this test the 4-inch, 3-ply burlap caught the greatest average, 302 larvae per band (Fig. 75). The 4-inch paper-burlap, 2-ply, averaged 246; and the 4-inch paper-burlap, single thickness averaged 240; while the 4-inch single thickness roofing paper was the least effective, averaging only 138, and the 4-inch single thickness crêpe paper next to the poorest, averaging 160.

On Sept. 7 the rows of bands were transposed to the positions shown in Table 1, Test 2. In this test the 8-inch paper-burlap, single thickness, was the best, averaging 319 larvae per band; the same material, 4 inches wide, 2-ply, averaged 250 and the same material 4 inches wide and

single thickness, averaged 232. The three least efficient materials were: 4-inch burlap, 2-ply, averaging 141; 2-inch paper-burlap, 2-ply, averaging 192; and 4-inch roofing paper, averaging, 195.

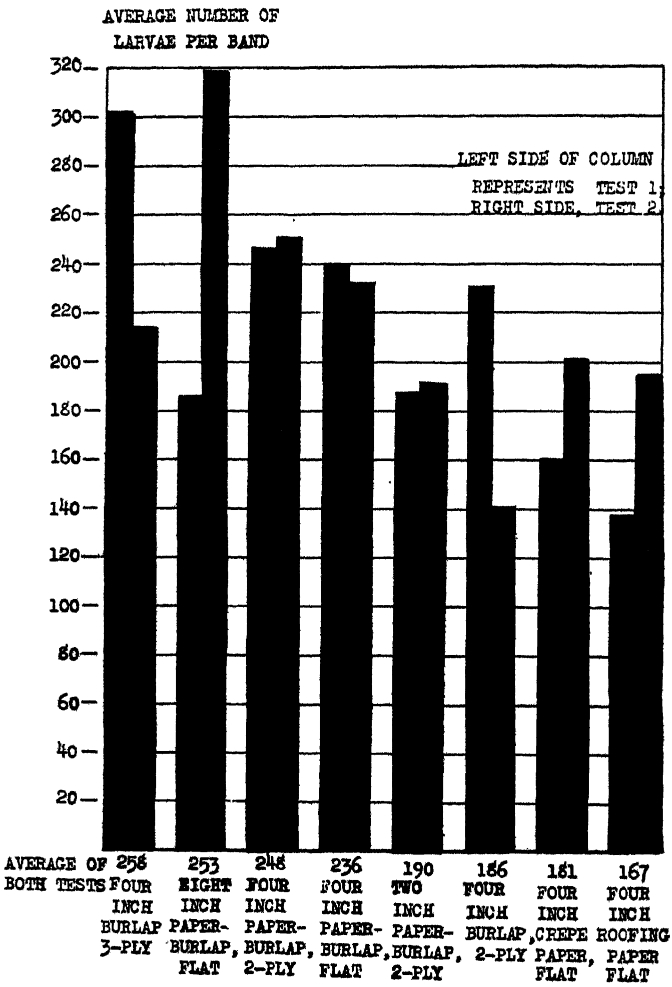

FIG. 75.—Average number of codling moth larvae caught in untreated bands, Siegert orchard, Yakima, Wash., 1927. Left side of column, Test 1, June 23 to Sept. 7; right side of column, Test 2, Sept. 7 to Oct. 28.

Obviously field heterogeneity played an important part in the results in the two preceding tests as indicated by the change of rank of effectiveness of the several items due to change of location in the plat.

By averaging the two tests together (Fig. 75) it appears that the 4-inch burlap, 3-ply, was the most effective, averaging for the two tests 258 larvae per band, the 8-inch paper-burlap, single thickness, a close second, averaging 253, and the same material, 4 inches wide, 2-ply, a close third with an average of 248. The three poorest were: 4-inch roofing paper, averaging 167; 4-inch crêpe paper, averaging 181; and 4-inch burlap, 2-ply, averaging 186 larvae per band.

Had the experiment been terminated at the end of the first test, or had only the second test been made, or had both series been combined in one test, only one interpretation would have been reached. From the two tests as made, however, the correct conclusion is not yet available, but certain facts are apparent.

HAUETER ORCHARD, 1928. The orchard used in 1928 was so badly infested that all of the fruit was wormy and unharvested. The trees were much larger than those used in 1927, and somewhat more uniform in size, but probably about as variable as to crop and other factors, and in addition consisted of several varieties. The rows of untreated bands were interspaced with rows of treated bands. The trunks were cleaned of most of the rough bark, and the bands applied July 10 and examined every 7 days until Sept. 11, after which 9 days intervened between each examination.

No new materials were tested in 1928.

In this test there was a much wider range in values between the better and the poorer materials than in the 1927 experiments. (Table 2.)

The best material (Fig. 76) was the 8-inch paper-burlap band, single thickness, averaging 1,322 larvae per band, while the second best was the same material 4 inches wide (except that the 4-inch material on both trunk and limbs caught more per tree). The least efficient was the crêpe paper which averaged only 336, and next to the poorest was the 6-inch 2-ply burlap, which averaged 472 larvae per band.

TABLE 2. NUMBER OF CODLING MOTH LARVAE CAPTURED UNDER UNTREATED BANDS. HAUETER ORCHARD. YAKIMA, WASH., 1928
(July 10–November 14)

Row No.	Kind of band	Number of trees	Total number of larvae	Average number of larvae per tree
1	Paper-burlap, 4-inch, single thickness	14	14,400	1,029
2	Paper-burlap, 8-inch, single thickness	13	17,181	1,322
5	Crepe paper, 4-inch, light colored, single thickness	13	4,374	336
6	Burlap, 4-inch, 3-ply	13	8,971	690
11	Paper-burlap, 4-inch, single thickness	14	12,934	924
14	Burlap, 6-inch, 2-ply	12	5,658	472
15	Paper-burlap, 4-inch, single thickness, on trunk and limbs	10	12,097	1,210
	Total	89	75,615	

Accurate orchard comparisons of banding materials can be made only under the following conditions: the trees must be uniform in size, in the character of the bark, in variety of fruit, in size of crop, and in degree of infestation. Obviously also the comparisons must run simultaneously, all bands must fit uniformly on all trees, and supplementary places

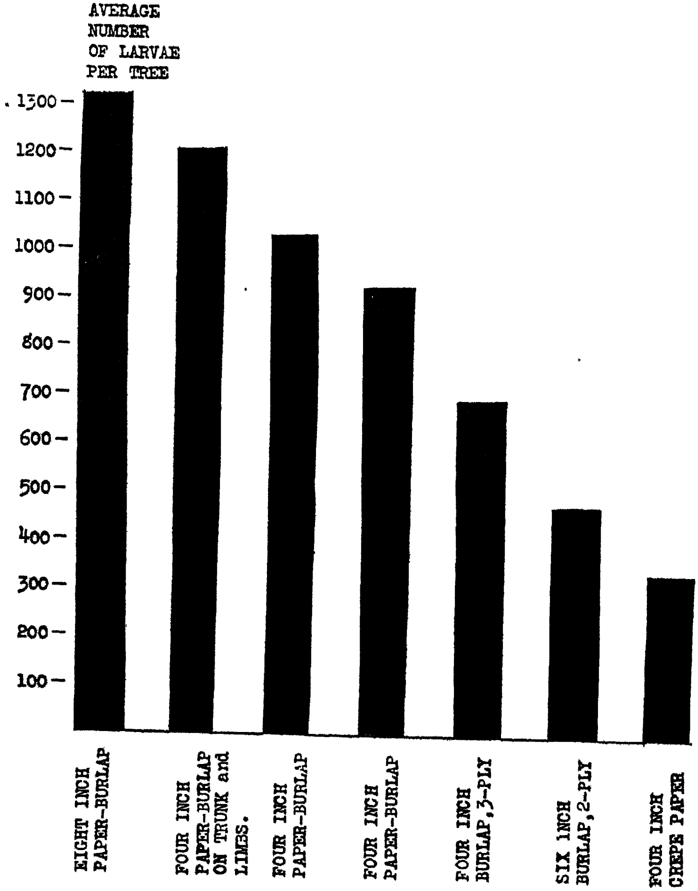

FIG. 76.—Average number of codling moth larvae caught in untreated bands, Haueter orchard, Yakima, Wash., 1928.

for pupation and hibernation must be uniformly equal. In no case that we can recall have all of these conditions prevailed. Large bands requisite for large trees cannot be compared with small bands on small trees; smooth-bark trees cannot be compared with rough-bark trees; especially susceptible varieties are not comparable with those much less

so; a crop of 1 bushel on a tree is not comparable with a crop of 30 bushels on another. A variation in the amount of light surrounding the banded trees has also been mentioned as a factor.[1] Owing to many variable factors the comparisons must be made simultaneously; loosely or poorly fitting bands are not comparable with snugly fitting ones; and bands on tree trunks surrounded with extraneous material suitable for pupation or hibernation purposes are not comparable with bands on trunks free of or differing in such supplementary quarters.

The tendency toward a rational average, for each item, in spite of any or all of the foregoing variables (except variety of fruit), is more or less increased as the number of trees in each test is increased or by replication or repetition of the tests. The more complete the elimination of all variables, the sooner comparable results are obtained. The more numerous or important the variables, the less accurate are the results, and the more repetition or replication is required to reach accurate deductions; this is especially true in cases where the items compared are not likely to show wide differences. In cases where there is a wide range between compared items, fairly accurate or approximate comparisons can be made more readily.

Most of the foregoing variables existed in these tests except that the comparisons were run simultaneously, the bark was cleaned rather uniformly, and there was but a single variety of fruit in the first two tests. However, by using a number of trees for each material, and by duplication and repetition of tests, some points of value are apparent.

Conclusions

Paper-burlap bands are as effective as the 3-ply burlap customarily used, and cost much less.[2]

Four-inch, single thickness paper-burlap bands were apparently not quite so efficient as single thickness 8-inch bands.

Folding the 8 inch paper-burlap bands to double thickness, with the open edge down, did not increase their effectiveness.

Four-inch paper-burlap was slightly more effective applied as a single thickness than when folded to 2-ply with the open edge down. The 2 inch band thus formed was apparently too narrow.

[1]Flint, W. P., and Goff, C. C., Banding for Codling Moth Control. In Journ. Econ. Ent. 22, p. 675–679, 1929.

[2]Paper-burlap is priced at 2⅔ cents per lineal yard in 8-inch widths; at 1⅓ cents in 4-inch widths. The 3-ply, 4-inch burlap costs 6 cents per lineal yard at Yakima, Wash.

Three-ply, 4 inch burlap proved more efficient than 2-ply whether 6 or 8 inches in width.

Crêpe paper, light colored, single thickness, 4 inches wide was next to the least effective in both tests in 1927, and the least effective in the 1928 test.

Four-inch paper burlap on both trunk and limbs was apparently somewhat more effective than on trunks alone.

THE RELATION OF THE HABITAT TO EUROPEAN CORN BORER POPULATIONS

By J. R. Savage, *Ohio Agricultural Experiment Station*

Abstract

Differences in habitats within the corn borer (*Pyrausta nubilalis* Hubn.) infested area are offered as a reasonable explanation of the differences in populations occurring in Ohio. Corn borer populations are correlated significantly with types of habitat.

It has been observed that the populations of European corn borer (*Pyrausta nubilalis* Hubn.) in Ohio fluctuate widely within the infested area. In a previous publication (1) it was pointed out that these variations were in large part accounted for in their relation to the habitat. It is the purpose of the present paper to lend additional support to these former observations.

As an introduction to the discussion which follows, the value of using the habitat as an index to favorable conditions will be considered. There are two independent groups of major factors, physical and biotic, which could be mainly responsible for such a variation. Physical factors may be divided into climate and soil. Climate may be eliminated at the outset, for altho the extremes of climate occurring in the infested area might be used to explain the differences in the populations in those extremes, climate cannot serve to explain the differences in the populations in adjacent fields. The soil and biotic factors are closely related and one or the other can be used with relative accuracy to account for the differences in the populations of adjacent fields, since where these factors are most favorable the greatest accumulations of corn borers will result. However, soil exercises only an indirect influence on corn borer populations thru its effect on the corn plant. The biotic factors offer the best indicator of population differences. The habitat forms an index for biotic factors and at the same time it is influenced by both climate and soil. It represents the resultant condition of the reactions and interrelations of all factors present.

During the season of 1928 data were taken in over 200 fields in the Bono area. Four types of habitat were characteristic of this region: swamp-forest (2), red-oak-transition, beech-maple, and muck. The majority of these fields embraced two or more of the habitats within their limits. However, among the entire number were found 34 in which the habitat was unmixed. In this lot of fields containing a single habitat all four types were represented. These fields were coded from 1 to 4 for their habitat type and the values arranged according to the corn producing ability of the habitat. From the poorest to the best in the production of corn they run as follows: (1) muck, (2) beech-maple, (3) red-oak-transition, and (4) swamp-forest. Correlating these coded habitats with their respective corn borer populations, the correlation coefficient is .48 with odds 1454 to 1 that the correlation is significant.

This correlation is relatively higher than it appears when some of the evaluable factors at work are considered. Date of planting, growth condition of corn, and height at peak of moth flight are some of the definite factors which affect corn borer populations (3). The planting date of these 34 fields, varied from May 7 to June 2. Some of the fields were tile drained, others were not. Some fields were fertilized. Still others were properly rotated and some had been in corn for years. The average height of the fields at the peak of moth flight varied from 39 to 52 inches. Any of the above factors may be more or less significantly correlated with corn borer populations. Since all of these factors have an effect on the degree of favorableness of a given habitat when subject to such variation, they cause a considerable deviation in the value of a given habitat from its true value and, therefore, lower the correlation coefficient.

The swamp-forest offers the most favorable conditions for corn borer accumulation. A correlation was made of the approximate percentage of the areas in swamp-forest[1] of 23 northern Ohio counties with their respective corn borer populations (4). This gave a correlation coefficient of .41 with odds of 55 to 1. Here again the correlation is not as high as might be expected, if favorableness of habitat is correlated with corn borer populations. Since the swamp-forest habitat does not cover an entire county and the corn borer population is not confined to the swamp-forest, an error is introduced into the calculation. This is aggravated by the fact that the corn borer has not been within the limits of all these counties for the same number of years and, therefore, the accumulations have been building up for unequal lengths of time.

[1]Transeau, E. N. and Sampson, H. C., unpublished reconnaissance survey of the forest types in Ohio made for the Department of Entomology, Ohio Agricultural Experiment Station, 1926–28.

From the above it would follow that where the greatest percentage of swamp-forest occurred the greatest increase in corn borers should occur. This is the case. The correlation coefficient is .54 with odds of 20789 to 1 when a correlation is made between the percentage of swamp-forest in 23 northern Ohio counties and their respective increases or decreases in corn borer populations.

SUMMARY. The habitat offers a reasonable explanation of differences in corn borer populations within the infested area of Ohio. A relatively high correlation between types of habitats and corn borer populations occurs even when definite limiting factors are known to vary widely. In any of the 23 northern Ohio counties considered, the corn borer population is correlated significantly with the respective amount of swamp-forest within the county. The rate of increase in any one of these counties is significantly correlated with the percentage of swamp-forest occurring in it.

LITERATURE CITED

1. HUBER, L. L., NEISWANDER, C. R. and SALTER, R. M. 1928. The European Corn Borer and Its Environment. Ohio Agr. Exp. Sta. Bul. 429, pp. 169–178.
2. SAMPSON, H. C. 1927. The Primary Plant Associations of Ohio. Ohio Jour. Sci. Vol. 27, pp. 301–309.
3. NEISWANDER, C. R. and HUBER, L. L. 1929. Height and Silking as Factors Influencing European Corn Borer Population. Ann. Ent. Soc. Amer., Vol. 22, pp. 527–542.
4. U. S. D. A. 1929. European Corn Borer Infestation Survey. Michigan-Indiana-Ohio-Pennsylvania-(Western) New York, pp. 20–37.

CORRELATION OF CORN BORER POPULATION WITH DEGREE OF DAMAGE

By C. R. NEISWANDER and E. A. HERR,[1] *Ohio Agricultural Experiment Station*

ABSTRACT

Varying populations of the European corn borer, *Pyrausta nubilalis* Hubn., were established on different plots of each of three varieties of corn and the resulting effect on yield was ascertained. It was found that within the variety there was a direct correlation between borer population and reduction in yield, and that for the three varieties under observation there was an inverse correlation between per cent reduction in yield and length of season between planting and silking.

The question of degree of reduction in yield due to corn borer infestation is one that vitally concerns all persons interested in corn production. It is of economic interest to corn growers who wish to know how to measure losses caused by the insect, since such information is

[1]The writers desire to acknowledge the assistance of Dr. L. L. Huber who has contributed greatly to the analysis of the data.

necessary before they can decide to what extent they can spend effort and money in an attempt to prevent these losses. And the question is of particular importance to investigators attempting to develop control measures since upon it rests the proper interpretation and evaluation of their results.

From casual observation in the field it is practically impossible to arrive at even a fairly accurate approximation of the damage being done because of the nature of the injury caused by the insect. If the corn borer would attack one field and leave uninjured a neighboring field of a similar variety, equal quality and the same development rate the two might be compared, but such a condition has never been found to exist. On the contrary such fields are very likely to have approximately equal infestations. Because of the extreme variations in yield that occur as a result of differences in soils, planting dates, varieties, rotations and other farm practices it is extremely difficult to establish fair expectation levels from which to make comparisons. For this reason no accurate measure of damage done by the corn borer can be made by correlating population with yield in neighboring fields.

If an attempt is made to compare yields from infested plants with those from non-infested plants where both have been equally exposed to attack the data are of but little, if any, value. It has been shown that the larger and better plants within an area are more susceptible to infestation. Hence the infested stalks by reason of their greater vigor may be able not only to carry their borer load but actually may outyield the weaker uninfested ones, a condition which actually has been found to exist in some early investigations.

A decrease in production as a result of the presence of borers in dent corn is not distinctly observable by superficial examination until a population of three or four borers per stalk has been reached and the actual reduction in yield is usually not regarded as severe until a borer population of six or eight borers per stalk has occurred. The variations in damage due to fluctuations in population should be measurable, however, even with variations in population no greater than one borer per stalk, provided separation of the different populations can be made and environmental conditions kept uniform.

Probably the first and most prominent indication that borer damage is being done in a corn field is the breaking of the tassels and infested stalks. While stalk breakage is not a specific measure of the reduction in yield resulting from the presence of corn borers it is nevertheless a distinct indication of corn borer injury. The amount of breakage that occurs within a field having a given population will depend, of course,

upon the weather conditions, degree of maturity, and the type of corn grown. However, the average breakage that occurs over a number of different varieties, each having a range of populations and all being subjected to the same weather conditions should be proportional to the borer population.

In Table 1 is given the percent of stalks broken and the percent detasseled for various populations under observation in 1927. The populations considered were the averages obtained from six varieties observed for the three main planting dates of the year. In obtaining this record a total of 510 stalks were observed for each population. In columns three and five the average amount of stalk breakage and detasseling per borer that occurred are computed respectively for the different population levels.

TABLE 1. SHOWING BORER POPULATION CORRELATED WITH PERCENT STALK BREAKAGE AND DETASSELING

Population per stalk	Percent broken		Percent detassled	
	Actual	Av. per borer	Actual	Av. per borer
3.27	22.1	6.8	56.9	17.3
2.04	18.2	8.9	50.3	24.7
1.31	9.5	7.3	28.9	22.1

Bul. 429 Ohio Agr. Exp. Sta. p. 129.

It may be seen that as the population increases there is a coincident increase in both percent broken and percent detasseled stalks, the coefficient of correlation between stalk breakage and population being .85. The odds calculated from the formula $t = \frac{r}{\sqrt{1-r^2}} \times \sqrt{n'-2}$ as given by Fisher are over 9,999 to 1 that the correlation is significant. The regression of percent of stalk breakage on population is 6.09. That is, considering all varieties for the three population levels shown in the table, the stalk breakage increased 6.09 percent for each borer per stalk increase in population.

During the season of 1928 a definite effort was made to ascertain the relationship existing between reduction in yield and increase in borer population. Accordingly, five plots ten hills square were selected for study in a uniformly growing field of early planted corn. These plots were examined for eggs every second day throughout the egg deposition season, the location of the egg masses being recorded by hills on a chart for each plot.

In order to produce the desired variation in population on the different plots all eggs were removed from plot one and their equivalent placed on plot five; half of the eggs were removed from plot two and their

equivalent placed on plot four; while plot three was left undisturbed except that a complete record was made of all eggs deposited. In this way there was established among the plots a ratio in egg deposition of 0, 1, 2, 3, 4. The final egg deposition record for all plots was as given in Table 2.

TABLE 2. SHOWING EGG RECORD ON DAMAGE PLOTS (BONO—1928)

Plot No.	Egg masses	Eggs per plant	Ratio
1	6	.4	1
2	149	9.5	25
3	320	19.9	54
4	472	27.9	79
5	626	35.8	104

In taking the final record the individual ear weight was noted for each stalk of the different plots and the borer population for the respective stalks was obtained. In this way the population and damage could be correlated for the different plots. In like manner the ear weights for individual stalks could be correlated with the respective borer populations for those stalks regardless of the plots in which they occurred. The final plot record of population and damage is shown in Table 3.

TABLE 3. SHOWING CORRELATION OF BORER POPULATION WITH YIELD—BONO—1928

Plot No.	No. of plants	Total No. borers	Borers per stalk	Yield in bu. per acre
1	159	270	1.69	73.55
2	157	439	2.79	71.85
3	158	581	3.67	69.23
4	172	870	5.05	58.90
5	177	1111	6.27	67.26

The data presented in Table 3 tend to indicate that the yield is reduced progressively as the borer content per stalk is increased. The coefficient of correlation between borer population and yield is — .7496, but the odds are only 12 to 1 that this correlation is not due to chance.

Soil differences, growth records, silking dates, and farm practices were all observed for the different plots in order to note if any factor other than population might be responsible for the differences in yield obtained. In only one respect was there found to be a difference that might be thought to cause a variation in yield. Plots one to four were cultivated at silking time while plot five was not. Since the cultivation was rather deep it is possible that the yield on the cultivated plots was materially reduced and that plot five, therefore, had a proportionately higher yield than its population would warrant. It is also possible that the increase in yield in plot five may have been due to some other unknown factor.

During the season of 1929 a more complete damage project was planned and executed. Six levels of population were established on

each of two field corn varieties, Smoky Dent and Burr Leaming, and three replications were made for each level. In addition one sweet corn variety, Golden Bantam, was grown with three levels of population and two replications for each level.

The plots of all varieties and all replications were six hills square with one infested border row entirely around the plot to secure an even distribution of population throughout, and with two uninfested border rows surrounding the infested plot to take up the migrating larvae. The infestations in all population levels for each variety were initiated at the same time in order that the developing larvae might all be subjected to the same general environmental conditions.

The field in which the experiment was conducted was fairly uniform in topography, soil type and texture. However, due to unfavorable moisture conditions during the forepart of the season a somewhat uneven stand resulted. There was not sufficient moisture present to produce uniform germination. This condition undoubtedly affected the yield as well as the percent of survival, but since the irregularity was common to all plots of the experiment it should have little, if any, bearing upon the results obtained.

In obtaining the final record, individual ear weight was taken for each stalk of the different plots and the borer population for the particular stalk was noted as in the preceding year's work. In case of the sweet corn the reduction in yield was computed in the same manner as in the field corn except that the yield was taken during the roasting ear stage. The yield is thus based on the actual weight of roasting ears instead of on the15.5 percent moisture basis used for field corn.

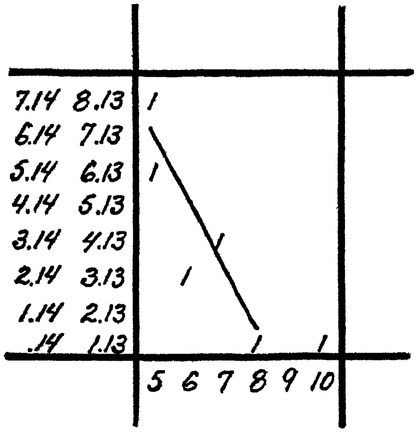

Fig. 77.—Showing Correlation of Population per stalk and Yield per stalk in Golden Bantam Sweet Corn.

The correlation between borer population and yield in Golden Bantam is —.7974 (Figure 77), the odds being 45.7 to 1 that there is a significant correlation. For each borer increase in population in this variety there was a reduction in yield of 5.4 percent as figured from the regression equation of population on yield using this correlation coefficient.

In the two field corn varieties, the population and yield records were both taken in the fall after the corn was mature. Moisture samples were taken for each plot and the yield figured on a 15.5 percent moisture basis.[2] The averages of the replications for each population level in Smoky Dent are given in Table 4.

TABLE 4. CORRELATION OF BORER POPULATION WITH YIELD IN SMOKY DENT VARIETY, OAK HARBOR—1929

Pop. level	Pop. per 100 stalks	Yield in bu. per acre
1	22	57.9
2	139	54.2
3	249	50.3
4	457	48.9
5	634	47.0
6	690	40.6

By reference to Table 4 it may be seen that as the population increases there is a steady decrease in yield, the highest population level obtained being 690 borers per 100 stalks where a reduction in yield of 17.3 bushels or 30 percent of the crop was obtained when compared with the first level alone as a check.

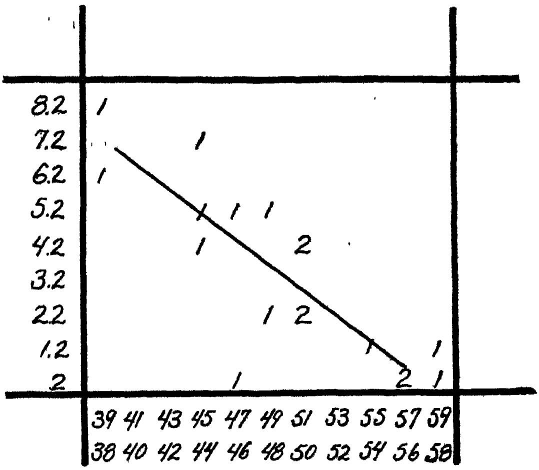

Fig. 78.—Correlation Table for Population versus Yield in Smoky Dent Field Corn.

The coefficient of correlation between borer population and yield in the Smoky Dent variety is —.8230 (Fig. 78) with odds of 9,999 to 1 that this correlation is significant. For each borer increase in population there was a reduction in yield of 3.25 percent.

[2]Moisture determinations were made by the Department of Agronomy.

In the Burr Leaming variety, due to lower establishment rates, the populations obtained in the different levels were lower than in Smoky Dent although the same number of eggs was used in the corresponding levels of the two varieties. The population per one hundred stalks and the yield in bushels per acre for the different levels are given in Table 5.

TABLE 5. CORRELATION OF BORER POPULATION WITH YIELD IN BURR LEAMING VARIETY

Pop. level	Pop. per 100 stalks	Yield in bu. per acre
1	10	59.1
2	57	54.3
3	120	52.3
4	176	53.1
5	276	49.7
6	356	50.0

The coefficient of correlation between borer population and yield in Burr Leaming is — .5875 with odds of 199 to 1 that this correlation is significant. For each additional borer increase in population there was a reduction in yield of 1.8 percent.

All of the damage records discussed in this paper occurred with populations under ten borers per stalk and for that reason do not necessarily apply to high populations. Nevertheless they should be comparable with each other. In Table 6 the silking dates, length of season between planting and silking and the percent reduction in yield for each borer increase in population are given for each variety used in the 1929 tests.

TABLE 6. SHOWING PERCENT DAMAGE PER BORER FOR THREE VARIETIES OF CORN, 1929

Variety	Average silking date	Days from planting to silking	Reduction in yield per borer
Golden Bantam	Aug. 9.4	73.4	5.4%
Smoky Dent	Aug. 13.5	77.5	3.25%
Burr Leaming	Aug. 20.2	84.2	1.8%

The foregoing data (Table 6) indicate that there is considerable variation in the damage resulting to different varieties from a given borer population, the amount of damage per borer increasing as the length of growing season of the variety decreases. Since, in general, the length of growing season of a variety is directly proportional to the size of the stalk the explanation of the above variation probably lies in the fact that in a variety like Golden Bantam the percentage of food and water conducting tissue that has been cut off by the borer tunnel is much higher than in a large stalk variety like Burr Leaming. Conse-

quently the influence of each borer of population on the percentage of transportation of food material is correspondingly less as the size of plant increases and as a result, the smaller stalk varieties suffer greater damage.

CONCLUSION. In planning this project it was hoped that by ascertaining the ratio existing between borer population and reduction in yield, the damage occurring within any field could be readily computed after determining the borer population. However, the results of the investigations reported here indicate that there is not likely to be established a specific formula, based upon borer population per stalk alone, for measuring damage that will apply to all varieties, soils, planting dates, seeding rates, crop rotations and weather conditions. The writers believe that the same populations established on the varieties presented here would not produce identical results another year because of the above mentioned factors. Nevertheless the amount of damage per average borer of population can be correlated in a general way with the nature of the variety according to the scale given in Table 6.

THE EFFECT OF TEMPERATURE, RELATIVE HUMIDITY AND EXPOSURE TO SUNLIGHT UPON THE MEXICAN BEAN BEETLE

By D. F. MILLER,[1] *Field Assistant, Truck-Crop Insect Investigations, Bureau of Entomology*

ABSTRACT

This series of laboratory experiments and field tests indicates that there is a specific relation between relative humidities and temperatures in the survival of the Mexican bean beetle (*Epilachna corrupta*) at high summer temperatures.

Experimental studies like those of Shelford (*9*)[2] and Headlee (*4*), and some more recent work like that of Chapman (*2*), Beattie (*1*), and Hefley (*5*) have indicated that atmospheric humidity and evaporation rate are very important factors in the life histories and ecology of insects. To some extent this also seemed to be true for the Mexican bean beetle, according to field data collected by Howard[3] and Douglass (*3*). It

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[2]References made by number in italics refer to literature cited at end of paper.

[3]Howard, Neale F. Studies on the atmospheric evaporation in relation to bean beetle abundance. Unpublished notes.

seemed advisable, therefore, to make a rather careful study of this problem under completely controlled conditions in order to determine with some exactness how important were the effects of these factors upon the bean beetle.

APPARATUS. A single unit of the apparatus that was constructed to control and measure the humidity and evaporation rates is shown in Figure 79. Six units were used in order to make possible the running of a variety of humidities simultaneously. The materials used were sulphuric acid, saturated solutions of sodium hydroxide, sodium bromide, sodium chloride, sodium nitrate, and distilled water; and the percentages of relative humidity obtained by their use were approximately 0, 30, 56, 73, 80, and 100.

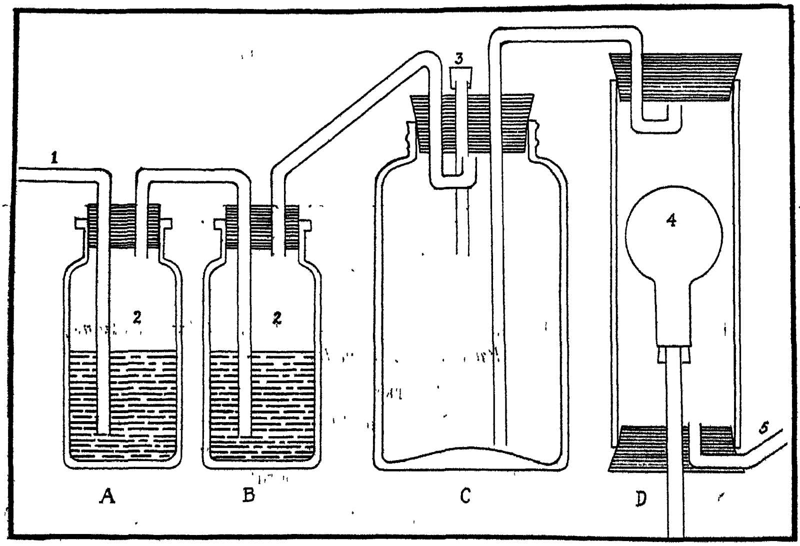

Fig. 79.—A and B, Bottles containing solutions to produce known relative humidities. C, Experimental chamber where beetles were placed during the experiment. D, Glass cylinder containing atmometer over which air was drawn in order to get the relative rates of evaporation. 1, Glass tube furnishing the inlet for the air current. 2, Salt solution or acid through which air was drawn to give it a known relative humidity. 3, Tube through which a thermometer was thrust to obtain the temperature of the inside of the experimental chamber. 4, Atmometer for recording the rate of evaporation. 5, Outlet tube connected with the pump on the water tap.

Parts A and B, bottles containing solutions producing known vapor tensions, and part C, a honey jar used as an experimental chamber, are similar in principle to apparatus used previously by Headlee and by

Hefley. Part D is a glass cylinder closed at both ends by rubber stoppers. The standard porous cup atmometer was placed inside the cylinder and the air from the experimental chamber C entered the upper end of the tube and passed down around the atmometer cup and out through the outlet, 5, to a suction pump attached to a water tap. Separation of the atmometer from the experimental chamber insured the correct percentage of humidity in the chamber.

RELATIVE EVAPORATION RATES AT NORMAL TEMPERATURES. Of all the parts of the life history it was decided that those most susceptible to the effects of evaporation and humidity would be: (1) incubation, (2) larval period, (3) ecdysis, (4) pupation period, and (5) emergence. The first of these was postponed because of certain difficulties involved, but the others were tried, since mature larvae could be started, ecdysis would occur at time of pupation, the pupae would remain quiescent during the pupal period, and emerge as adults, all without feeding.

Mature larvae which had stopped feeding and most of which had already attached themselves preparatory to pupation were put into small screen-wire cages and placed in the experimental chambers (Figure 79, C). They were left here until they had passed through the pupal period and emerged as adults. They were examined daily during this period and records made of their condition.

Temperatures in the experimental chambers were checked three times per day and averaged. The greatest variation in temperature for any one day was from 25.8° to 31.1° C.; and for the entire period, from 22.1° to 31.1° C. The results of running the experiment for thirteen days are summarized in Table 1.

TABLE 1. SUMMARY OF THE EFFECTS OF RELATIVE HUMIDITY AND RATE OF EVAPORATION ON THE LATER STAGES OF THE MEXICAN BEAN BEETLE

Per cent of relative humidity	Evaporation (cc.)		Number of larvae started	Number of larvae pupating	Number of adults emerging	Per cent of survival
	Daily	Total				
0	25.14	264.0	31	31	31	100
30.7	17.83	187.2	31	31	30	96.6
56.18	8.2	94.3	31	30	29	93.3
73.4	6.60	69.7	31	30	30*	100
80.03	5.70	65.6	31	30*	30	100
100.0	1.06	12.3	31	30	30	96.6

*One individual killed in handling.

These figures show that for the extremes of dry and saturated air the percentages of pupation and emergence were very high and at no degree of relative humidity did the survival fall below 93 per cent, a figure well above normal for field conditions.

Table 2. Survival of Adults of the Mexican Bean Beetle Exposed for Three Hours to High Temperatures and Different Relative Humidities

Per cent of relative humidity	Temperature °C.	Number of beetles used	Number of beetles killed	Number of survivals	Per cent of survivals
0.0	37.5	100	3	97	97.0
30.72	37.5	100	1	99	99.0
56.18	37.5	100	2	98	98.0
73.414	37.5	100	3	97	97.0
80.035	37.5	100	7	93	93.0
100.0	37.5	100	2	98	98.0
Check	26.0	100	2	98	98.0
0.0	38.5	260	128	132	50.8
30.72	38.5	260	105	155	59.6
56.18	38.5	260	97	163	62.7
73.414	38.5	260	51	209	80.4
80.035	38.55	260	118	142	54.6
100.0	38.5	260	180	80	30.8
Check	26.6	260	17	243	93.5
0.0	39.5	260	166	94	36.2
30.72	39.5	260	166	94	36.2
56.18	39.5	260	158	102	39.2
73.414	39.5	260	87	173	66.5
80.035	39.5	260	163	97	37.3
100.0	39.5	360	235	25	9.6
Check	27.3	260	1	259	99.6
0.0	40.5	100	92	8	8.0
30.72	40.5	100	92	8	8.0
56.18	40.5	100	84	16	16.0
73.414	40.5	100	66	34	34.0
80.035	40.5	100	99	1	1.0
100.0	40.5	100	100	0	0.0
Check	25.0	100	0	100	100.0
0.0	41.5	100	98	2	2.0
30.72	41.5	100	97	3	3.0
56.18	41.5	100	91	9	9.0
73.414	41.5	100	81	19	19.0
80.035	41.5	100	99	1	1.0
100.0	41.5	100	100	0	0.0
Check	25.5	100	2	98	98.0
At all humidities	42.5	100	100	0	0.0
Check	26.0	100	5	95	95.0

Table 1 shows clearly that for normal summer temperatures with no sudden or great variations; for relative atmospheric humidities varying from approximately 0 per cent to approximately 100 per cent, and for relative evaporation rates varying from 1.06 cc. to 25.14 cc. per day the Mexican bean beetle is sufficiently resistant to pass through its final ecdysis, pupation, and emergence with no apparent effect from the abnormal conditions.

Relation of Relative Humidity to Temperature. The failure of the experiment of relative humidity and evaporation rate at ordinary

summer temperatures to disclose any effect upon the beetles from the late larval stage to adult, led to the idea of testing relative humidity with higher temperatures. Some previous work with temperature by Kramer (*6*), Miller and Gans (*7*), Miller (*8*), and especially Beattie (*1*) and Hefley (*5*) showed that temperature is a vital and perhaps the most important single factor in insect life and activity.

Apparatus: Parts of the apparatus used in the preceding experiment (Figure 79, A, B, C,) were installed in a large electrical oven for the regulation of temperatures.

TABLE 3. SURVIVAL OF LARVAE AND PUPAE OF THE MEXICAN BEAN BEETLE EXPOSED FOR THREE HOURS TO HIGH TEMPERATURES AND DIFFERENT RELATIVE HUMIDITIES

Per cent of relative humidity	Temperature °C.	Number of larvae used	Per cent of survival	Number of pupae used	Per cent of survivals
0.0	37.5	100	96	100	99
30.72	37.5	100	100	100	97
56.18	37.5	100	99	100	100
73.414	37.5	100	100	100	99
100.0	37.5	100	97	100	98
Check	—	100	94	100	97
0.0	38.5	100	88	100	83
30.72	38.5	100	91	100	94
56.18	38.5	100	93	100	93
73.414	38.5	100	96	100	95
100.0	38.5	100	94	100	79
Check	—	100	97	100	95
0.0	39.5	200	88	100	86
30.72	39.5	200	88	100	89
56.18	39.5	200	82.5	100	85
73.414	39.5	200	89	100	94
100.0	39.5	200	88	100	90
Check	—	200	98	100	92
0.0	40.5	110	60	120	30
30.72	40.5	110	68.1	120	39.2
56.18	40.5	110	77.2	120	35
73.414	40.5	110	91	120	46.6
100.0	40.5	110	82.7	120	40
Check	—	110	97.2	120	92.5
0.0	41.5	130	2.3	100	6
30.72	41.5	130	10.7	100	0
56.18	41.5	130	0.0	100	1
73.414	41.5	130	10.7	100	3
100.0	41.5	130	3.1	100	4
Check	—	167	86.8	100	89
0.0	42.5	100	3	100	0
30.72	42.5	100	4	100	0
56.18	42.5	100	3	100	0
73.414	42.5	100	1	100	0
100.0	42.5	100	0	100	0
Check	—	100	98	100	93

Methods and results: When the oven had reached a given constant emperature the beetles were counted out and placed in the experimental

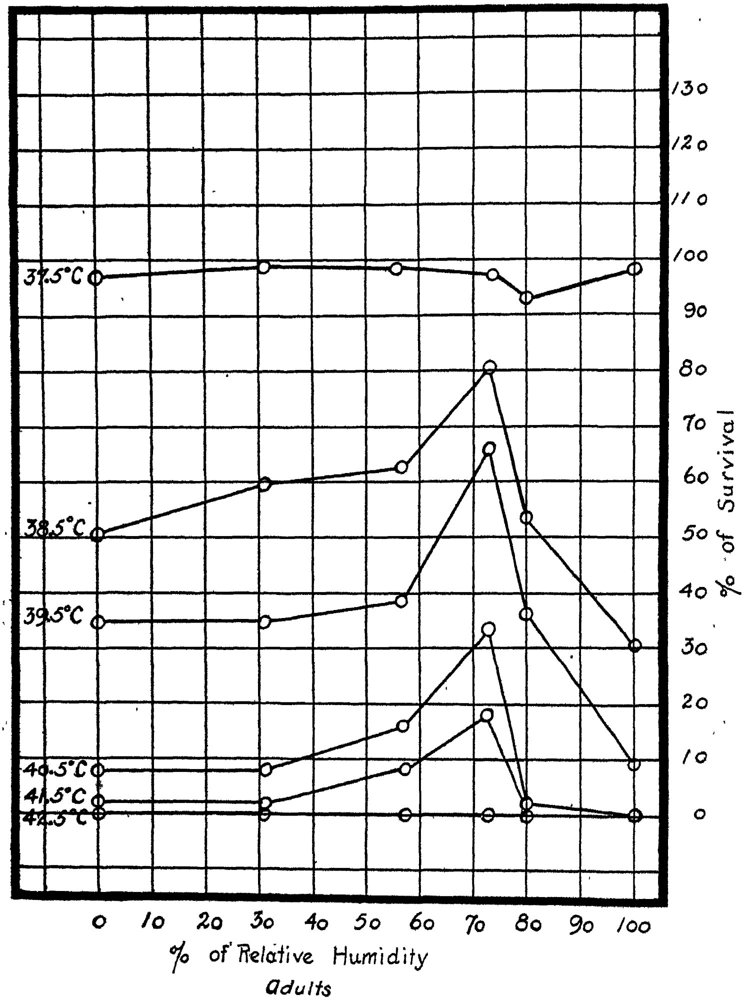

Fig. 80.—Chart showing the effects of exposure to various temperatures at different relative humidities upon the survival of adults of the Mexican bean beetle. (The percentages of survival in the checks were 98, 93.5, 99.6, 100, 98, and 95; see Table 2.)

chambers of the apparatus (Figure 79, C), an equal number in each chamber, and exposed to the temperature for three hours. After the exposure they were removed and allowed to stand from fourteen to sixteen

hours, and then the beetles were removed and carefully examined to determine the percentage which had survived. For comparison, in each

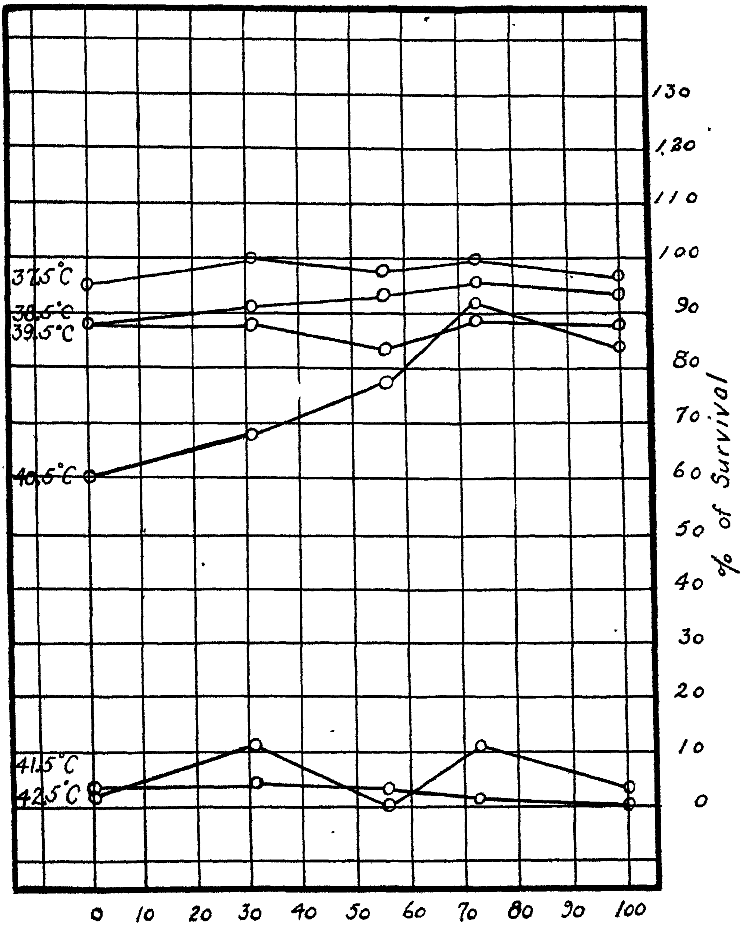

Fig. 81.—Chart showing the effects of exposure to various temperatures at different relative humidities upon the survival of larvae of the Mexican bean beetle (The percentages of survival in the checkswere 94, 97, 98, 97.2, 86.8, and 98; see Table 3.)

experiment, a check chamber was run outside the oven at room temperature. The very definite results obtained are summarized in Tables 2 and 3.

On the graphs of Figures 80, 81, and 82 the temperatures used (37.5,° 38.5,° 39.5,° 40.5,° 41.5,° 42.5° C.) are shown along the left margin; each per cent of relative humidity (given in Tables 2 and 3) and each per cent of survival of the larvae, pupae, and adults is indicated by the position of a circle with reference to the scale at the bottom and at the right, respectively. These should be compared with the results of the checks (as given in the legends of the figures) to obtain the true kill. It will be noticed here that at 37.5° C. there was normal survival at all humidities giving nearly a straight line. For a 1° rise in temperature, however, there was a marked kill below 60 per cent and above 80 per cent relative humidity, with a very decided optimum at about 73 per cent. For temperatures of 39.5° C., 40.5° C., and 41.5° C., the results are very similar, with a decidedly lower per cent of survival for each increase of one degree of temperature. For a temperature of 42.5° C., one degree higher, there was an almost complete kill at all humidities and the curve becomes essentially a straight line. Regardless of the temperature, the optimum humidity is near 73 per cent. These results are somewhat similar to those obtained by Hefley (*5*).

From the graphs it is apparent that there is a critical thermal increment at about 40.5° C. Below this temperature there is no great gap in the percentages of survival for each rise of 1° C., and above it the same holds true, but from 39.5° C. to 41.5° C. there is a wide break.

Egg hatch: All attempts to determine the effects upon per cent of hatch in eggs showed tendencies toward results similar to that for other stages, but the mortality was so high even in checks that the results were not considered valid and hence are not presented.

The results of this series of experiments show very clearly the definite relationship between temperature and humidity. While the temperatures used were all high they are within the range of an occasional hot spell for climate such as may be found in the United States from Ohio south. They are well below the temperature frequently reached at the surface of the ground where exposed to the summer sun. The three-hour exposure was chosen as representing the probable duration of high temperature for any one day.

The fact that from 37.5° C. down there was no effect of either temperature or humidity explains why the first experiment on relative humidity and rate of evaporation gave completely negative results.

Field Tests. Exposure to sunlight: In order to check in the field some of the results obtained by the preceding laboratory tests, pupae were exposed to bright direct sunlight. The leaves containing pupae were turned over and tied to stakes so as to expose the pupae to the direct

rays of the sun. Different lengths of time were taken for the exposure and days were chosen when comparative temperatures varied consider-

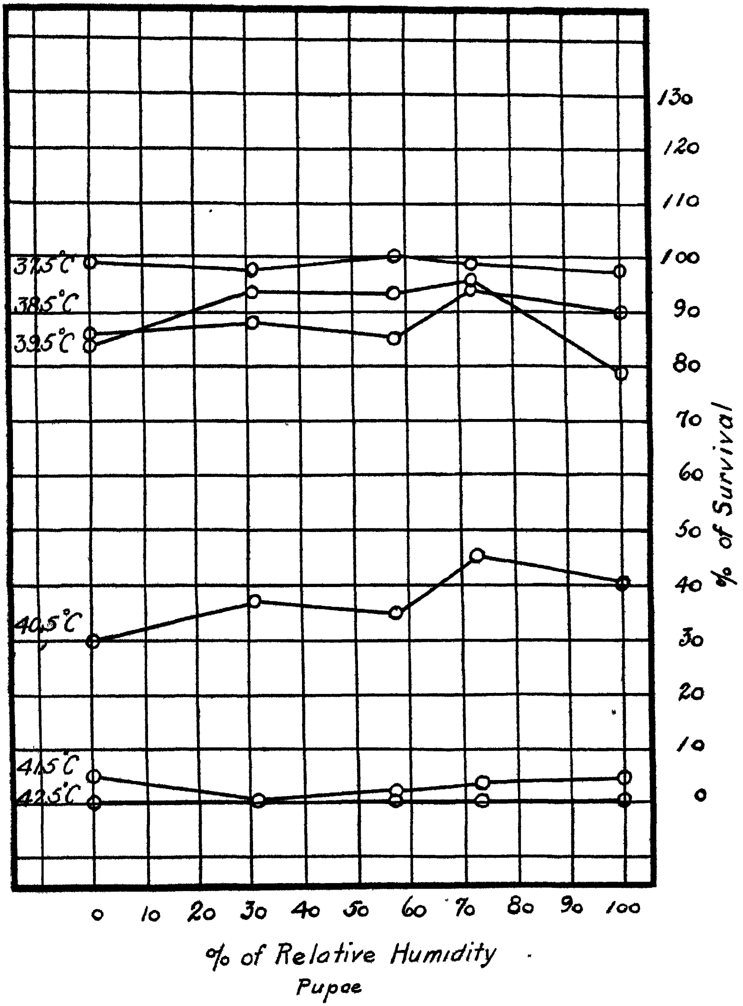

Fig. 82.—Chart showing the effects of exposure to various temperatures at different degrees of humidity upon the survival of pupae of the Mexican bean beetle. (The percentages of survival in the checks were 97, 95, 92, 92.5, 89, and 93; see Table 3.)

ably so as to make it possible to test for the effects of temperature and light rays separately. The results, which are summarized in Table 4, show:

a. That exposure for short periods (3 hours), when the temperature is high, kills pupae, since only 32 per cent of the exposed pupae emerged while 91 per cent of a check emerged.

b. That exposure for longer periods (15–18 hours) has practically no effect if the temperature is not high.

c. That it seems probable that temperature is more important than light rays in killing when exposure occurs in the field.

TABLE 4. EFFECTS OF EXPOSURE OF PUPAE TO MID-DAY SUN

Number of pupae	Length of exposure Hours	Hours of day	Mean temperature °C.	Number alive	Number died	Percentage of survival Experiment	Check
64	3	12.00–3.00	35	20	44	32	91
64	15	9.00–12.00	26.5	56	8	88	98
106	18	11.30–7.30	24.5	102	4	96.2	88

Position of beetles on the leaf: The question of the orientation of insects upon their host plants is a matter of both biological and economic importance. This is especially true in artificial control. The Mexican bean beetle, like many other insects, is usually found upon the under surface of the leaf where it feeds, ordinarily not breaking through the upper surface. Various explanations for this limitation of its activities have been suggested, usually with very little supporting evidence.

a. Response to gravity. Since the question is one of position, geotropism naturally suggests itself as an explanation.

b. Differences in leaf surface. This involves a number of things, such as the different nature of the surfaces themselves, the clinging ability of the beetle, the difference in humidity, the ability of the beetle to feed on one surface rather than the other, etc.

c. Response to light or heat of the sun. It has been observed that many more beetles are found on the upper surface of leaves just after daybreak than during later hours of the day.

A few specific tests were made which gave considerable definite information upon these points. A potted bean plant was suspended in an inverted position in bright sunlight. A number of beetles were placed upon the leaves in a place exposed to the direct sunlight. In most cases this was the under surface of the leaf which was now turned uppermost. The beetles immediately showed signs of restlessness and moved about until they came to the shaded side of a leaf. This was usually the upper surface which, being inverted, was not now exposed to direct light. If the leaf was turned edgewise with neither surface above or below, the beetle "chose" the shaded side regardless of which one it was. The response was negative to either the light or temperature which was about 34° C. in the sun on this day. The beetles had been taken from cages where food was not plentiful. Feeding commenced almost at once and

those beetles which came to rest upon the upper leaf surface began feeding upon it as readily as those on the lower surface.

To check these rather obvious results, a screen was placed in such a position as to shade the plant from direct sunlight. Then a mirror was set beneath the plant and the light of the sun reflected up against the leaves. This placed most of the beetles in the bright light again, whereupon they showed signs of restlessness and moved to less lighted areas as before.

This experiment was repeated later at a time when the temperature was not above 28° C. and the same results were apparent.

It would seem from the above that the distribution of the Mexican bean beetle upon the plant was primarily influenced by the intensity of the light rather than by gravity, leaf surface, ability to feed, or temperature, although they may respond to these influences when light does not enter in.

To test this, larvae were placed on plants which were then kept in a dark room. Counts made over a period of several days gave a total of 125 larvae on the under surface of leaves as compared with 84 on upper surfaces, stems, and cage walls. Other experiments carried on at the same time in a dark room by Howard and Mason in connection with a different project showed very similar distribution in the dark. Feeding had taken place on all parts of the plants, which seems to indicate that the only factor of much importance is light.

Literature Cited

1. Beattie, Mary V. F. (1928). Observations on the thermal death points of the blow-fly at different relative humidities. Bull. Ent. Research, 18 (4): 397–403, illus.
2. Chapman, R. N. (1928). The quantitative analysis of environmental factors. Ecology, 9 (2): 111–122, illus.
3. Douglass, J. R. (1928). Precipitation as a factor in the emergence of Epilachna corrupta from hibernation. Jour. Econ. Ent. 21: 203–213, illus.
4. Headlee, T. J. (1917). Some facts relative to the influence of atmospheric humidity on insect metabolism. Jour. Econ. Ent. 10: 31–38.
5. Hefley, H. M. (1928). Differential effects of constant humidities on Protoparce quinquemaculatus Haworth, and its parasite, Winthemia quadripustulata Fabricius. Jour. Econ. Ent. 21: 213–221, illus.
6. Kramer, S. D. (1915). The effect of temperature on the life cycle of Musca domestica and Culex pipiens. Science, n. s. 41: 874–877.
7. Miller, D. F., and Gans, M. (1925). Some observations on the reactions of the ant Cremastogaster lineolata (Say)to heat. Jour. Comp. Psych. 5 (6): 465–473.
8. Miller, D. F. (1929). Determining the effects of change in temperature upon the locomotor movements of fly larvae. Jour. Exp. Zool., 52 (2): 293–313, illus.
9. Shelford, V. E. (1913). The reactions of certain animals to gradients of evaporating power of air. A study in experimental ecology. Biol. Bull. 25: 79–120, illus.

A QUALITATIVE ANALYSIS OF THE DIGESTIVE SECRETIONS OF THE LARVA OF THE JAPANESE BEETLE (*POPILLIA JAPONICA* NEWM.)[1]

By MILLARD C. SWINGLE, *Assistant Entomologist, Bureau of Entomology, United States Department of Agriculture*

ABSTRACT

An analysis of the secretions of the digestive tract of larvae has shown the presence of the basic ions of aluminum, ferrous iron, calcium, magnesium, potassium, sodium, and ammonium. The acidic ions found present were carbonate, chloride, nitrite, and phosphate.

The inorganic ions are, from the standpoint of economic entomology, among the more important constituents of insect digestive secretions. They directly influence the reactions taking place within the digestive tract, particularly between the digestive secretions and foreign compounds introduced as stomach poisons. In this connection a study of the various ions present is of considerable importance to the economic entomologist.

The following paper is a qualitative study of the inorganic ions present in the digestive secretions of the larva of the Japanese beetle, *Popillia japonica* Newm. In order to test for those ions normally present, and to eliminate those which are incorporated in the food, overwintering larvae were first fed on high-grade filter paper for a period of four days to insure complete displacement of the soil within the digestive tract. The larvae were then dissected and the contents of the entire digestive tract removed and analyzed for any inorganic constituents.

METHOD AND RESULTS. The larvae used in this work were selected from a lot dug between January and March, special attention being given to selecting only the healthiest specimens. Three hundred of these larvae were brought into the laboratory where the average temperature was about 75° F. and were held in a box of soil until used. A large quantity of high-grade, practically ashless filter paper was crumpled up in the hand and moistened with distilled water. This moist paper was placed in one-ounce, seamless, tin salve boxes to each of which was added a single larva. The tins were then placed in a constant temperature chamber and held for four days at a temperature of 80° F., at which time the larvae had fed on the filter paper and had displaced all the soil within their digestive tracts.

After displacement of the soil within the digestive tract by filter paper, the larvae were opened by cutting along the mid-dorsal line

[1]Contribution No. 81. Research Laboratories, Moorestown, New Jersey.

from the posterior forward, and pinning out in a paraffin dissecting dish. The body cavity and digestive tract were then washed with several changes of distilled water from a pipette. This water was then removed and the contents of the entire digestive tract withdrawn with a pipette having a moderately fine point.

The material from 200 larvae was removed and placed upon a round filter paper in a round dish such as a bacteriological culture dish. This dish was kept under a warm desk light to permit the evaporation of all liquids from the paper. When thoroughly dried in this manner and the lid of the dish replaced, the material can be kept indefinitely. When ready for analysis the filter was folded, placed in a glass funnel over a 200 cc. flask, and 100 cc. of hot distilled water, slightly acidified with nitric acid, was poured repeatedly through the paper. This solution was then stoppered and labeled "Solution A" for the determination of basic constituents.

The material from another hundred larvae was collected in a 100 cc. flask and made up to 50 cc. with distilled water. The flask was then stoppered and labeled "Solution B" for the determination of ammonium and acidic constituents.

ANALYSIS OF SOLUTION A. The solution was first evaporated in a casserole and heated with concentrated sulfuric and nitric acids to destroy the organic matter (*1*).[2] It was then evaporated to dryness and 16 cc. of 6 N. sulfuric acid and 20 cc. of water added to dissolve the residue. The solution was then divided into 18 cc. portions which were placed in separate 50 cc. flasks and analyzed.

The first portion of solution A was analyzed by the procedure outlined by Noyes (*1*) for the analysis of basic constituents. The basic ions found in the solution were aluminum, iron, calcium, magnesium, potassium, and sodium. Other ions tested for but not demonstrated were silver, mercury, lead, bismuth, copper, cadmium, arsenic, antimony, tin, chromium, manganese, zinc, cobalt, nickel, barium, and strontium. In the course of this procedure the phosphate ion was detected.

The second portion of solution A was analyzed by the procedure given by Scott (*2*). The results were identical with those given above.

ANALYSIS OF SOLUTION B. This solution was analyzed by the procedure given by Noyes (*1*). The basic constituent, ammonium, was detected in 5 cc. of this solution. Two cc. of the solution were analyzed to determine the state of oxidation of the iron, which was found to be ferrous. The remainder was analyzed for acidic constituents. Those found were carbonate, chloride, and nitrite. Those tested for but not demonstrated were sulfate, sulfite, chromate, fluoride, oxalate, sulfide,

[2]Reference is made by number (italic) to Literature Cited, below.

cyanide, ferro- and ferricyanide, chlorate, hypochlorite, iodide, thiocyanate, bromide, and nitrate.

SUMMARY. A qualitative chemical analysis of the digestive secretions of the larva of the Japanese beetle has shown the presence of the following ions: aluminum, ferrous iron, calcium, magnesium, potassium, sodium, ammonium, carbonate, chloride, nitrite, and phosphate.

LITERATURE CITED

1. NOYES, A. A., Qualitative chemical analysis of inorganic substances. Ninth edition, pp. 190. The MacMillan Company, New York. 1924.
2. SCOTT, W. W., Standard methods of chemical analysis. Third edition, pp. 714, figs. 74, pls. 3. D. Van Nostrand Company, New York. 1922.

A COMPARISON OF THE TOXICITY OF PARA-DICHLOROBENZENE AND NAPHTHALENE TO THE CONFUSED FLOUR BEETLE (*TRIBOLIUM CONFUSUM* DUV.) (COLEOPTERA)

By RUSSELL S. LEHMAN, *Iowa State College, Ames, Iowa*

ABSTRACT

Large numbers of *Tribolium confusum* were treated under controlled conditions with naphthalene and para-dichlorobenzene. The apparatus consisted chiefly of a closed system in which air was drawn over sulfuric acid to give the desired humidity and then through the compound before going through the exposure bottles. The entire system was confined in a constant temperature chamber maintained at 30° C. Saturated para-dichlorobenzene acts as a strong anesthetic to *Tribolium confusum*. On the basis of the time required to kill 50% of the insects, naphthalene was found to be from ten to fourteen times as toxic to *Tribolium confusum* as para-dichlorobenzene at the same concentration.

Practically all of the early workers on insect fumigants determined the minimum concentration required to kill 100% of the insects in a fixed period of time. Moore (1917a, 1917b) determined the concentration of various benzene derivatives required to kill 5 house flies in 400 minutes.

Jewson and Tattersfield (1922) found that naphthalene at saturation had no apparent effect on mites after 16 hours. Para-dichlorobenzene at saturation anesthetized them after 3 or 4 hours and after 16 hours all were so affected that none recovered after exposure to air.

Tattersfield, Gimingham, and Morris (1925) found that naphthalene had a more toxic action than para-dichlorobenzene on *Aphis rumicis* L.

Strand (1930) exposed *Tribolium confusum* to various compounds at a constant temperature. He considered thirty insects enough for each

test since Trevan (1927) used thirty mice in his experiments with cocaine and stated: "A significant increase of accuracy above that given by this group number is only obtained by the use of greatly increasing numbers of animals; whilst diminution of the group number below 30 leads to a very rapidly increasing error." Trevan injected the mice intravenously and varied the doses according to the weight of the animals. Whether or not a comparison can be made between Trevan's method and a method whereby 30 insects are picked at random regardless of size is open to question. Both Trevan (1927) and Strand (1930) use the 50% kill point or the concentration which will kill 50% of the animals. This seems to be the best point statistically for a comparison of toxicities.

Bottimer (1929) compared the effect of naphthalene and para-dichlorobenzene as repellents to clothes moth larvae. He found that neither compound had any apparent effect upon the larvae when left exposed in an ordinary sized room.

Fleming (1925) compared the action of naphthalene and para-dichlorobenzene as soil insecticides for control of the Japanese beetle. He found that naphthalene was more effective against the larvae than para-dichlorobenzene, but that the latter compound was more effective than the former against the egg and adult.

Description of Apparatus. The apparatus used in these experiments is similar to that employed in the war gas experiments and in Allison's (1928) work with hydrocyanic acid.

Figure 83 is a diagram of the apparatus employed in the comparison of the toxicity of para-dichlorobenzene and naphthalene. In order to illustrate the operation of the apparatus, the course of the air through the system will be traced. The air enters at (a) and the total flow is recorded by the clock meter (b). Bottles (c), (d), and (f) of two and one-half liter capacity contain sulfuric acid of sufficient density, 1.320 at 30°C., to give a relative humidity of 60 to 65 per cent. Bottles (e) and (g) contain glass wool to take up the acid spray. The flow of the air over the para-dichlorobenzene in the tube (j) of the generating train is controlled by the screw clamp (h) and shown on the flow meter (i). A three liter bottle (k) mixes the vaporized para-dichlorobenzene of the generating train with air from the dilution train. The exposure train in which the insects were placed consists of six 250 c.c. flasks (l, m, n, o, p, and q). The tube (r) contains naphthalene which was used to check the total flow of air through the system. The flow meter (s) gives the total flow of air and should be the same as the clock meter (b). The screw clamp (t) regulates the air through the entire system. The 15

liter vacuum bottle (u) was used to steady the flow of air. A two and one-half liter bottle (w), partly filled with water, acts as a suction regulator with the screw clamp (v) helping to control the amount of suction. The water suction pump was located at (x).

When a saturated atmosphere of para-dichlorobenzene or naphthalene was desired, the generating train was removed from the system and the tube of para-dichlorobenzene or naphthalene was placed at (y). The dilution train then became the generating train.

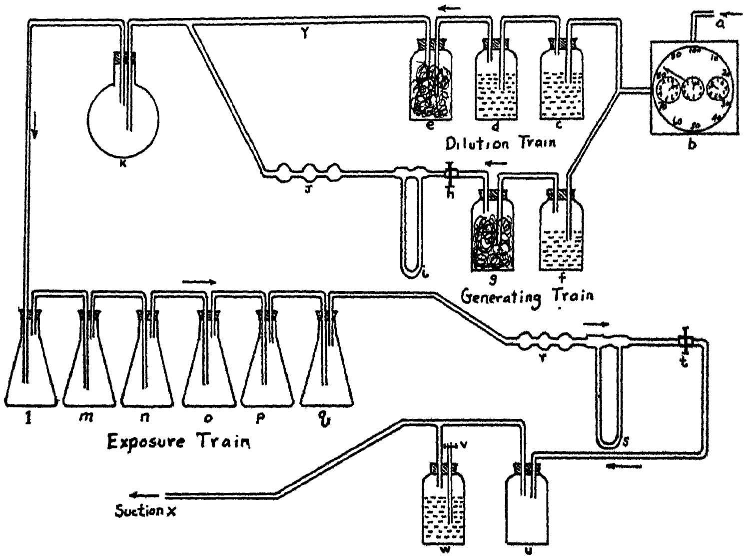

FIG. 83.—Diagram of apparatus for toxicity comparisons.

The entire apparatus was confined in a constant temperature chamber at a temperature of 30°C. The temperature was controlled by the use of a mercury thermo regulator and a mercury relay operated by a six volt radio battery and connected to the regular 110 volt alternating current with light bulbs as a source of heat. The air in the chamber was kept in motion by the use of an electric fan.

The humidity through the system was determined by the use of wet and dry bulb thermometers and checked very closely with the calculated humidity that should be obtained with sulfuric acid of the density contained in the humidity bottles used.

METHOD OF PROCEDURE. *Tribolium confusum* Duv. was used in all of the experiments. The insects were bred in battery jars containing whole wheat flour at a temperature of 30°C., maintained by a constant

temperature chamber. A relative humidity of 60 to 70% was obtained by the use of a saturated sodium chloride solution.

In the first experiments only 20 insects were used in each flask, but the number was increased to fifty, and finally most of the experiments were performed with 100 insects in each flask or 600 insects at each exposure. A total of more then 25,000 insects were used in this investigation. An exact number of insects was obtained in most cases by allowing the insects to walk up a white cardboard and then carefully counting them into each flask. None of the insects were used more than once.

The flow meter, which had been calibrated against a gas clock meter, was set so that a flow of about 60 liters an hour was maintained when a saturated atmosphere was desired. The tube containing the naphthalene or para-dichlorobenzene was first weighed on a chemical balance and then placed in the system. This tube was reweighed after the completion of the experiment. The loss in weight was the amount of naphthalene or para-dichlorobenzene taken up by the air. The amount volatilizing in a certain volume of air checked very closely with the calculations published by Roark and Nelson (1929). The gas clock meter was placed in the system to record the flow of air when the exposure continued over a long period of time. The successive results obtained with naphthalene checked so closely that it was decided to use naphthalene in the system as a check in obtaining the total flow of air.

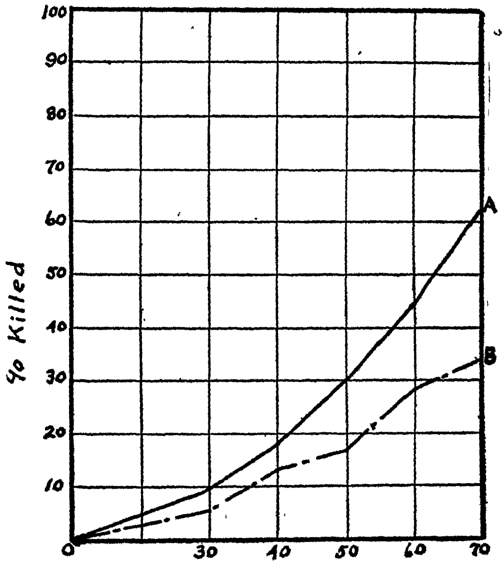

FIG. 84.—Para-dichlorobenzene at saturation, 0.000078 moles per liter. At each point plotted, 250 insects were used. Time in minutes.

At the beginning of the experiment air was passed over the compound from 30 minutes to one hour before the insects were placed in the exposure bottles. This was done so that the air and the compound in the mixing bottle would be of the proper proportion to pass immediately into the exposure bottles when the insects were placed therein.

At the conclusion of the experiment the insects were removed immediately from the fumigatorium and after examination they were placed in bottles containing whole wheat flour. These bottles were placed in a constant temperature chamber as previously described under the breeding of cultures. The first careful examination was made at about 24 hours after exposure. Insects that were unable to walk at this time were considered dead. All of the insects were then returned to the bottles containing whole wheat flour and examined one week later. Where the exposure lasted for several days, controls containing the same number of insects were carried along under the same conditions except that they were not exposed to the compounds. All the experiments were conducted in a constant temperature chamber where the temperature never varied more than 0.2°C.

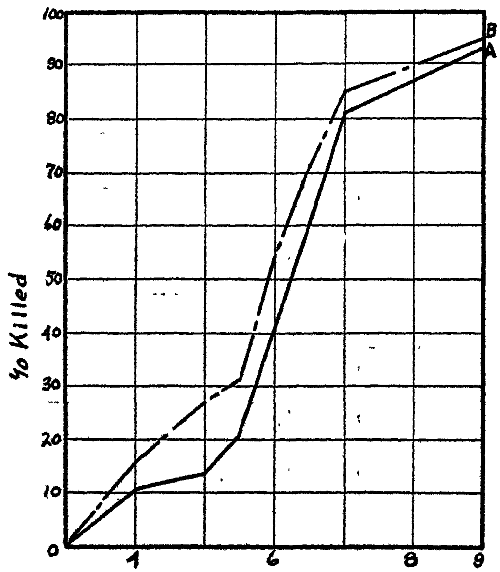

FIG. 85.—Naphthalene at saturation, 0.0000067 moles per litre. Time in hours.

The naphthalene and para-dichlorobenzene used in all of the experiments were purified by dissolving in ether, filtering, and allowing to crystallize. The excess ether was evaporated before the compounds were used.

Discussion and Results. In making the observations, it was necessary to select some criterion of death. The writer called an insect dead at the 24 hour observation if it was unable to walk. In all cases, with the exception of para-dichlorobenzene at saturation, insects that could not walk at the 24 hour observation never recovered sufficiently to be counted alive at the one week observation. The anesthetic property of the para-dichlorobenzene was so strong that the insects were still anesthetized when the 24 hour observation was made but a large number recovered before the one week observation. This can readily be seen by referring to Table 1. Jewson and Tattersfield (1922) also noticed this anesthetic property of para-dichlorobenzene on mites.

This result was not obtained when the concentration of para-dichlorobenzene was reduced to the same concentration as naphthalene. The comparison was made on a molecular basis. The concentration of naphthalene at saturation (30°C.) was 0.000852 grams per liter or 0.0000067 moles per liter. Para-dichlorobenzene at the same concentration on a molecular basis will contain 0.000985 grams per liter since the molecular weight of para-dichlorobenzene is 147 and that of naphthalene 128.

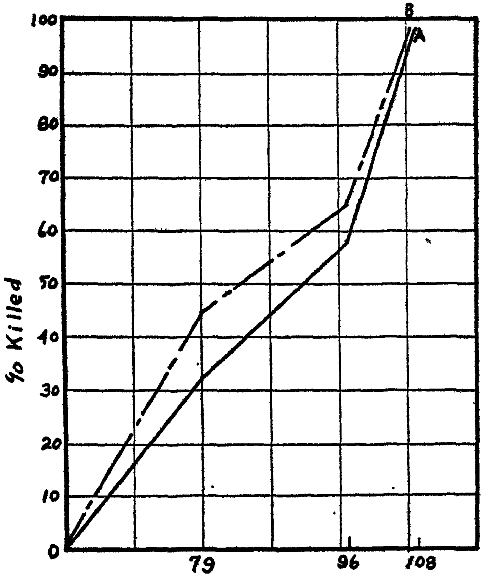

FIG. 86.—Para-dichlorobenzene at the concentration of 0.0000067 moles per liter. Time in hours.

As it was necessary to expose the insects for a much longer time with para-dichlorobenzene at the low concentration to obtain the same per cent kill as that obtained with naphthalene, the insects were finally killed instead of being just anesthetized. In all cases a larger number were dead at the one week observation than at the 24 hour observation. Natural death will not account for this difference since control samples were run along with the others and deductions were made for deaths found in the control. This difference will readily be noticed by referring to Table 3 and then to Table 1.

*TABLE 1. RESULTS WITH PARA-DICHLOROBENZENE AT SATURATION, 0.000078 MOLES PER LITER

Time in min.	Observation after 24 hrs. No. of expts.	Ave. % killed	S.D.	Observation after 7 days Ave. % killed	S.D.
30	5	9.6	± 6.5	6.4	± 5.9
40	5	18.8	±10.2	13.2	± 8.8
50	5	30.0	±19.5	17.6	±13.4
60	5	44.0	±15.7	28.4	±11.5
70	5	62.0	±13.3	33.6	±19.6

*Fifty insects were used in each experiment. S.D. standard deviation $\sigma = \sqrt{\frac{\Sigma d^2}{N-1}}$.

TABLE 2. RESULTS WITH NAPHTHALENE AT SATURATION, 0.0000067 MOLES PER LITER

Time in hrs.	Observation after 24 hours No. of expts.	Ave. % killed	S.D.	Observation after 7 days Ave. % killed	S.D.
4	6	10.5	±8.3	15.7	±4.5
5	6	13.0	±4.1	26.8	±4.9
5½	6	20.3	±5.0	31.0	±3.9
6	6	40.7	±5.6	53.7	±3.7
6½	6	60.7	±8.1	70.2	±8.0
7	6	81.8	±7.4	84.5	±6.7
9	6	92.7	±6.6	94.2	±6.2

One hundred insects were used in each experiment.

Where the control samples were run, the calculations were made according to the method employed by Abbott (1925) for computing the efficiency of insecticides. $\frac{x-y}{x}.100$ = per cent efficiency of the insecticide or in this case the per cent actually killed. x = per cent living in control. y = per cent living after exposure.

The results obtained with para-dichlorobenzene at the same concentration as naphthalene as shown in Table 3 (A) differ quite widely from those shown in Table 3 (B). There are several possible explanations of this wide variation. It might be due to the difference in seasons as the results given in Table 3 (B) were obtained in the fall of 1929 whereas the results given in Table 3 (A) were obtained during the winter of 1930. Holt (1916) found the cockroach to be more resistant during the fall of the year. It may be possible that *Tribolium confusum* is more resistant at this season of the year. The difference may be due to the difference in the anesthetic property of the para-dichlorobenzene.

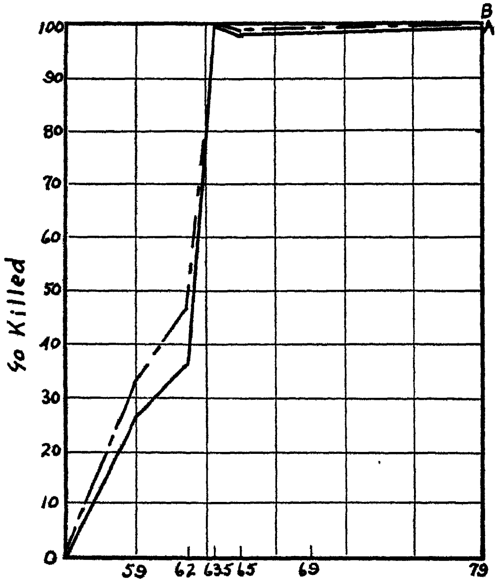

FIG. 87.—Para-dichlorobenzene at the concentration of 0.0000067 moles per liter. Time in hours.

TABLE 3. RESULTS WITH PARA-DICHLOROBENZENE AT THE SAME CONCENTRATION AS NAPHTHALENE AT SATURATION, 0.0000067 MOLES PER LITER

Time in hrs.	No. of expts.	Observation after 24 hours: Ave. % killed in control	Ave. % actually killed	S.D.	Observation after 7 days: Ave. % killed in control	Ave. % actually killed	S.D.
(A)							
59	6	2.2	26.6	±3.8	2.7	32.3	± 4.4
62	6	2.2	37.0	±7.3	2.7	46.6	±10.3
63½	6	2.2	100.0	—	2.7	100.0	—
65	6	4.3	98.1	± 1.6	5.3	99.3	± 0.9
69	6	4.3	98.0	± 1.6	5.3	99.5	± 0.9
79	6	5.0	98.6	± 1.7	6.3	98.6	± 1.9
(B)							
79	6	6.2	32.1	± 5.9	7.8	44.0	± 6.7
96	6	4.0	58.6	± 4.3	5.7	64.0	± 1.8
108	6	8.8	98.0	± 0.8	12.3	98.3	± 1.3

Two hundred insects were used in each experiment, 100 insects exposed and 100 insects in each control. The experiments in part (B) were performed two months previous to those given in part (A).

When the insects were examined immediately after being removed from the fumigatorium after being subjected to the influence of the para-dichlorobenzene or naphthalene, they were able to move their legs and antennae and in some few cases some were able to walk. It was noticed that the meta-thoracic legs were the first to be acted upon by the anesthetic. The insects in many cases were able to walk with the first two pairs of legs and drag the meta-thoracic legs along.

In a number of cases the females laid a large number of eggs soon after they were placed in the fumigatorium containing para-dichlorobenzene. At other times during exposure to the same compound, the ovipositor was extended and in some cases it was never drawn in after recovery. When the exposures extended over a long period of time and the final per cent killed was high, the insects during the latter part of the exposure had a convulsive reaction which consisted of periodic movements of the legs and antennae every few seconds.

Based on the time required to kill 50% of the insects, taken from the results summarized in Tables 2 and 3 (B) and shown graphically in Figs. 85 and 86, naphthalene appears to be 14 times as toxic to *Tribolium confusum* as para-dichlorobenzene of the same concentration. When a comparison of the results as compiled in Tables 2 and 3 (A) and shown in Figs. 85 and 87 is made, naphthalene appears to be only ten times as toxic. Therefore, on the basis of the time required to kill 50% of the insects, naphthalene is from 10 to 14 times as toxic to *Tribolium confusum* as para-dichlorobenzene at the same concentration.

The writer wishes to acknowledge his indebtedness to Dr. C. H. Richardson for suggesting this problem and for making many helpful criticisms as the work progressed. Many thanks are due to Dr. R. M. Hixon for information regarding the apparatus and its operation.

Literature Cited

Abbott, W. S. A Method of Computing the Effectiveness of an Insecticide. Jour. Econ. Ent. Vol. 18, pp. 265–267. 1925.

Allison, J. B. Studies on the Toxicity of Hydrocyanic Acid. Iowa State Coll. Jour. of Sic. Vol. 2, pp. 245–252. 1928.

Bottimer, L. J. Notes on Para-dichlorobenzene and Naphthalene as Repellents against Clothes Moth Larvae. Jour. Econ. Ent. Vol. 22, pp. 570–573. 1929.

Fleming, W. E. The Comparative Value of Carbon Disulfide and Other Organic Compounds as Soil Insecticides for Control of the Japanese Beetle. N. J. Agr. Expt. Sta. Bul. 410, pp. 1–29.

Holt, J. H. The Cockroach; Its Destruction and Dispersal. A Comparison of Insecticides and Methods. Lancet 1916, pt. 1, pp. 1136–1137. 1916.

Jewson, S. T. and Tattersfield, F. The Infestation of Fungus Cultures by Mites. Its Nature and Control, together with some Remarks on the Toxic Properties of Pyridine. Ann. App. Biol. Vol. 9, pp. 213–240. 1922.

Moore, W. Toxicity of Various Benzene Derivatives. Jour. Agric. Res. Vol. 9, pp. 371–381. 1917a.

——— Volatility of Organic Compounds as an Index of the Toxicity of their Vapors to Insects. Jour. Agric. Res. Vol. 10, pp. 365–371. 1917b.

Roark, R. C. and Nelson, O. A. Maximum Weight of p-dichlorobenzene and Naphthalene which can Exist in Vapor Form in a 1,000 cu. ft. Fumigating Chamber. Jour. Econ. Ent. Vol. 22, pp. 381–387. 1929.

Strand, A. L. Measuring the Toxicity of Insect Fumigants. Jour. Ind. Eng. Chem. Analyt. Ed. Vol. 2, pp. 4–8. 1930.

Tattersfield, F., Gimingham, C. T., and Morris, H. M. Studies on Contact Insecticides. Part III, A Quantitative Examination of the Insecticidal Action of the Chloro-Nitro- and Hydroxyl Derivatives of Benzene and Naphthalene. Ann. App. Biol. Vol. 12, pp. 218–262. 1925.

Trevan, J. W. The Error of Determination of Toxicity. Proc. Roy. Soc. London B 101, pp. 483–514. 1927.

FLY TRAPPING ON THE RANGES OF THE SOUTHWEST

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Abstract

The use of fly traps on the stock ranges of the Southwest has become somewhat extensive. In 1928 stockmen estimated the loss during that year from the screw-worm fly and fleece-worm fly to be $10,000,000. In 1929 the Bureau of Entomology, in cooperation with a local ranchmen's trapping association, conducted tests upon the effectiveness of systematic fly trapping in reducing the number of flies on an area of approximately 200 square miles of ranch land in Menard County, Texas. In comparison with a similar untrapped area a reduction of 36.2 per cent of the fly population in the trapped area by reason of the trapping was indicated. The most effective bait was found to be two pounds of fresh meat to which is added two gallons of water, and nicotine sulphate at the rate of four cubic centimeters per gallon of water. The frequency of renewing baits and refilling bait pans with water is dependent upon weather conditions.

While systematic organized fly trapping activities give promise of a distinct reduction in screw-worm and fleece-worm losses, the present prospects are that effective control can only be brought about by a combination of destruction of carcasses and trapping supplemented by approved ranch practices, and the possible utilization of parasites and predators of these blow flies.

The Bureau of Entomology announced a few years ago that great numbers of the screw worm fly, *Cochliomyia macellaria* Fab., and the black blowfly or so-called fleece-worm fly, *Phormia regina* Meig., might be captured in traps, and suggested the use of traps as a supplementary control measure for these flies. Since this announcement the use of flytraps has become somewhat extensive on the ranges of the Southwest. Under the direction of county agents, ranchmen are organized into associations for cooperative flytrapping. Some of the organizations employ a "trapper," who devotes his time to the care of the traps. Others have arranged for the individual ranch operators to care for the traps. In addition to these, individual ranches are being trapped independently by their owners or lessees. Conservative estimates based on the number of traps manufactured by tinners indicate that approximately 15,000 traps are being operated on ranches in southwestern Texas. This section, as well as other sections in the livestock area of the Southwest, is constantly increasing the number of traps in use and extending their operation over untrapped territory.

Reduction of losses from the screw worms and fleece worms is claimed by the majority of the organizations or individuals using traps, and this, no doubt, accounts for the extensive employment of this method of dealing with this important problem.

LOSSES FROM SCREW-WORM AND FLEECE-WORM CASES. In November, 1928, nearly 1,000 of the most prominent ranchmen of the Southwest met to discuss ways and means of combating the screw-worm fly and the fleece-worm fly. For that year they estimated the loss to the industry from this source to be $10,000,000. During the early fall of 1928 some sections suffered rather heavy losses, although as a whole that year cannot be considered as an unusual one, inasmuch as the average annual loss is generally considered as amounting to about that figure.

Although from the point of view taken herein the part played by flies in the causation of myiasis in animals is of major importance, it must also be remembered that flies exert in many ways a marked influence upon the welfare of the stockmen.

RECENT DEVELOPMENT OF RANGE TRAPPING. While the trapping of flies on ranches has been practiced during the active fly season for a

period of 4 or 5 years, unfortunately, no uniform or accurate records have been made from which to ascertain the degree of control which may be obtained by the use of traps.

The Bureau of Entomology, in cooperation with a well organized trapping association under the direction of County Agent W. R. Nisbet, in Menard County, Texas, started the task of securing accurate and comprehensive records on flytrapping during the fly season of 1929. Valuable and interesting information is being secured, which, when complete, should determine, in some degree at least, the value of flytrapping under practical conditions. The investigation under way has not as a whole progressed sufficiently during the past season to enable definite conclusions to be drawn. Certain phases of it, however, have given us information which we consider worthy of report at this time.

THE TEST AREA. The test upon which this report is based covers an area of approximately 200 square miles of typical ranch land situated in the northwestern part of Menard County, Texas. The elevation is from 2,000 to 2,200 feet above sea level. The rainfall is approximately 22.8 inches per year for an average of six years, according to available unofficial local records. Menard County lies in that section of the plains known as the Edwards Plateau. The area under consideration lies along the north side of the San Saba River, which properly begins in springs in the vicinity of Fort McKavett situated at the southwestern corner of this area. The topography of this area ranges from gently rolling and hilly to moderately rough and broken. The ridges throughout the area are very stony. Shallow, dry, rocky draws separate the hills. The vegetation consists of scattered low live oak, chinoak and mesquite, and various small thorny shrubs. Various weeds and grasses grow luxuriantly along the draws and hillsides when rainfall is sufficient. There is very little cultivation except along the river. Although the topography is usually not too rugged for the cultivation of small patches in this area, the presence of rocks on the surface of the shallow soil prevents its use for this purpose.

The environments encountered in the test area are very similar to those existing over millions of acres of ranch land in the livestock-raising districts of western and southwestern Texas. There are, of course, many local or sectional variations in any area of this size. Some of these were met with in the area under consideration. Range management in the test area is similar in most respects to that practiced throughout much of the region where screw-worm and wool-maggot

damage is a major problem. For this reason the results that are being obtained in the area in question will be applicable to much of the affected area.

The abundance of all flies and the per cent of the total fly population represented by each species have been carefully studied in this area during the period of greatest fly activity, March 1 to November 1. Although certain species of flies, particularly of the genera *Calliphora*, *Cynomyia*, and *Phormia*, are present in considerable numbers during the winter months, little injury is caused by them. For this reason trapping was discontinued during these months.

TRAPS AND THEIR OPERATION. There are 313 traps located in the test area, or 1 trap to approximately 407 acres. This ratio differs somewhat on individual ranches, but the distribution of the traps is rather uniform as a whole.

Baiting of the traps during the whole season was carried out systematically and in accordance with the best results previously obtained in extensive field experiments. Such experiments have proven that the most effective bait, considering availability and economy, consists, for each trap, of 2 pounds of fresh meat to which is added 2 gallons of water and nicotine sulphate at the rate of 4 cubic centimeters to a gallon of water. The addition of nicotine sulphate inhibits the develoment of larvae and does not interfere with the normal decomposition of the meat or reduce its attractiveness to flies. The meat which was utilized in the experiment reported on in this paper was obtained from old and inferior goats and sheep which were culled from herds within the test area and were slaughtered when needed. The frequency with which baits are renewed and the bait pans refilled with water between the renewals of the baits is largely dependent on weather conditions. The rate of decomposition of the meat and the evaporation of the water are greatly accelerated during the hot weather of the summer months. In this test it was found necessary to renew the baits at 15-day intervals during the summer months and at from 20 to 25 day intervals during the spring and fall. In order to prevent the drying of the baits, which renders them unattractive, it was necessary to refill the bait pans with water every 7 to 9 days during the summer months, and every 10 to 12 days during the cooler months.

QUANTITY AND SPECIES OF FLIES CAUGHT. At intervals of six weeks the flies in each trap were removed and measured. A total of 8,533 quarts of flies was trapped in the test area during the period from March 15 to November 1. At each time the traps were emptied samples were taken from traps representing all parts of the area. Two thousand

five hundred flies taken at random from each of these composite samples were determined as to species and sex. Table 1 shows the species taken, together with the per cent of each species and the proportion of the sexes.

TABLE 1. SPECIES OF FLIES CAUGHT, PERCENTAGE OF TOTAL CATCH REPRESENTED BY EACH SPECIES, AND THE PROPORTION OF THE SEXES

Species	Number of specimens	Per cent of total	Proportion of the sexes: Per cent males	Per cent females
Cochliomyia macellaria Fab	8,506	68.048	35.69	64.31
Cynomyia cadaverina Desv	29	.232	6.89	93.11
Calliphora coloradensis Hough	33	.264	27.27	72.73
Calliphora viridescens Desv	6	.048	0.00	100.00
Lucilia sericata Meig	2	.016	0.00	100.00
Lucilia unicolor Town	777	6.216	30.83	69.17
Phormia regina Meig	2,102	16.816	41.96	58.04
Musca domestica Linné	8	.064	25.00	75 00
Synthesiomyia brasiliana B. & B	72	.576	10.00	90.00
Muscina stabulans Fall	3	.024	0.00	100.00
Neomuscina tripunctata Vaw	1	.008	0.00	100.00
Sarcophaga spp.*	932	7.456	49.50	50.50
Ophyra aenescens Wied	4	.032	75.00	25.00
Ophyra leucostoma Wied	4	.032	0.00	100.00
Fannia trimaculata Stein	1	.008	0.00	100.00
Stenopterina brevipes Fab	2	.016	0.00	100.00
Tachinid spp	13	.104	11.12	88.88
Miscellaneous	5	.040	20.00	80.00
Total	12,500	100.000		

*At least 40 species were represented.

DISCUSSION OF TABLE 1. In analyzing Table 1 it will be noted that the two species *C. macellaria* and *P. regina*, which are responsible for practically all cases of myiasis in domestic animals, constitute nearly 85 per cent of the total of all species caught. The senior author has on several occasions reared *Sarcophaga robusta* Ald. from larvae taken from wounds of animals and on one occasion also *Cynomyia cadaverina*. However, these cases are rather rare, and can not be considered of economic importance. In the proportion of the sexes the table shows that females of nearly all of the species caught were represented in much greater numbers than the males. This is no doubt due to the fact that the strong odors emanating from the decomposing meat baits not only attract these meat-breeding species of flies for feeding, but also attract females for oviposition. That the proportion of the sexes indicated in the table does not exist normally in nature has been demonstrated by us with breeding experiments carried out in the field during the past season. Pupae and mature larvae collected near carcasses which had served for their supply of nourishment and which they had left voluntarily were placed in suitable breeding cages. The resulting adults were nearly all *C. macellaria*, and the sex of all the specimens

of this species was carefully determined. Out of a total of 6,150 specimens so produced, 3,139, or 51.04 per cent, were males and 3,011, or 48.96 per cent were females. We have no logical reason for believing that the sexes of other meat-breeding species of flies do not develop in nature in the same proportion as those of *C. macellaria*.

SEASONAL POPULATION AND ITS REDUCTION IN THE TEST AREA. Studies of comparative abundance were carried out in the test area and in a check area located 15 to 30 miles away. For these studies beef liver in an early state of decomposition and very attractive to flies, was exposed in quart fruit jars for definite periods. The number of flies of each species which entered the jars was recorded. Ten exposures in widely separated places in each of the two areas were made on the same day and hour at regular intervals during the trapping period. The results obtained from these tests showed an average reduction throughout the period of trapping of 36.2 per cent of the total fly population in the trapped area as compared with that in the untrapped area.

The reduction percentage given does not include natural reduction from climatic or other causes. The untrapped check area provided the basis for the reduction computation.

Since no other determinable factors of importance in relation to the reduction of flies existed in the test area, it seems probable that the 36.2 per cent reduction was due to the trapping of the 8,533 quarts of flies. If we add to this the theoretical 63.8 per cent, or 15,038 quarts of flies which escaped the traps, as shown by the jar tests, we have a total of 23,571 quarts of flies present during the active season in a relatively small area. By reducing this quantity to the actual numbers of flies contained therein, some idea can be obtained of the enormous numbers of these unwelcome pests inhabiting our extensive livestock-producing sections of the Southwest. Based on an actual count of 11 quarts of flies, which averaged 9,950 to the quart, the total fly population of the trapped area was estimated as 234,531,450.

For a long time the stockmen have been well aware of the potential source of damage that exists in this enormous number of flies. Their efforts in the past toward the control of this pest by trapping flies have been mostly along ineffective lines, on a small scale, and with no cooperative action. Consequently very little good has been accomplished.

With the introduction of organized effort the results of flytrapping so far recorded indicate that there is some hope for a distinct reduction of screw-worm losses. To those most familiar with the problem it is not conceivable, however, that trapping alone will be the solution. The

Bureau of Entomology continues to advocate the prompt destruction of all carcasses and other preventive measures.

It is our opinion that effective control can only be brought about by a combination of destruction of carcasses and trapping, supplemented by the general adoption of ranch practices which will tend to avoid screw-worm and fleece-worm attack on livestock, and possibly also by the utilization of parasites and predators of the immature stages of these insects.

THE MORE IMPORTANT INJURIOUS INSECTS OF HAITI

By ROGER C. SMITH and ANDRÉ AUDANT, *Service Technique Port-au-Prince, Haiti*

ABSTRACT

The paper lists under a host or a grouping the more important insect pests of Haiti by scientific name, family, and with a brief note of abundance so far as known. A brief summary of the main geographical, phenological and agricultural features of Haiti is given. The insect life shows a mingling of temperate and torrid zone forms. Some insects one might expect to find in Haiti but which are not known to occur are also mentioned.

Upon coming to Haiti, July 15, 1928, the senior writer was forced to familiarize himself with the more important economic insects of the country. Perhaps others also will be interested in knowing what they are, so this brief summary is presented herewith.

We have drawn freely upon information accumulated by Dr. Geo. N. Wolcott, formerly Entomologist of the Service Technique, particularly as recorded in his recently completed text book, in his annual reports, and in unpublished monthly reports. Many of the determinations are from the department collection and have been made through his efforts by the U. S. National Museum authorities and those at the British Museum. Acknowledgment is made to these sources of information utilized in this report. Dr. H. L. Dozier also has supplied some records and determinations.

GEOGRAPHY AND CLIMATE OF HAITI (WOODRING 1924). Haiti and Sto-Domingo occupy the island of Hispaniola which is the second largest island of the West Indies. Haiti occupies the western and more mountainous third. Its area is 10,204 square miles, approximately equal in size to the State of Maryland. The island is located just within the Tropics lying between 68°20′ and 74°30′ longitude and 17°39′ and 20° North latitude.

The climate of Haiti is tropical though it is a rather mild tropical climate. Table 1 gives a summary of weather data.

TABLE 1. METEOROLOGICAL DATA FOR PORT-AU-PRINCE, HAITI
ALTITUDE: 37 METERS

Month	Mean temp. centigr.	Monthly temperature range. Minimum and maximum with years	Mean month. rainfall	Range of rainfall. Min. and maximum with years. In millimeters
Jan.	25.7	24.5 (1910)—26.3 (1916)	32.2	0 (1887)—161.8 (1886)
Feb.	25.8	25.2 (1910)—26.3 (1913)	57.9	0 (1903)—230.9 (1902)
Mar.	26.3	24.7 (1910)—27.1 (1913)	93.8	7.6 (1900)—314.7 (1904)
Apr.	26.4	25.6 (1913)—27.2 (1916)	162.4	23.0 (1885)—362 (1866)
May	27.2	26.1 (1913)—27.8 (1914)	249.8	92.0 (1885)—464.6 (1889)
June	28.2	27.9 (1916)—28.8 (1915)	105.5	10.8 (1904)—346.6 (1916)
July	28.8	27.7 (1916)—29.6 (1914)	69.5	1.8 (1894)—150 (1866)
Aug.	28.5	28 (1909)—28.9 (1915)	139.4	27.4 (1919)—271.5 (1915)
Sept.	27.8	27.2 (1909)—28.4 (1914)	184.7	29 (1883)—455.6 (1910)
Oct.	27.1	26.6 (1912)—28.1 (1915)	169.6	51.5 (1886)—353.4 (1911)
Nov.	26.2	26 (1916)—27.2 (1915)	85.7	4.2 (1889)—246.9 (1909)
Dec.	25.6	24.7 (1916)—26.6 (1915)	35.0	0 (1918)—161.2 (1898)

Temperatures from Geology of Haiti, 1924, p. 38. Covering years 1909–1916 Rainfall from same, p. 47. Covering years 1863–1919. (Note: 25.4 mm. = 1 inch Degrees centigrade times 9:5+32 degrees = °F.) See Bulletins Hydrographiques 1–6 published by Direction Générale des Travaux Publics for annual summaries covering 1922–1928.

CROPS OF HAITI. Coffee is the most important crop of Haiti and fully three-fourths of the export revenue comes from this crop. Since coffee trees in Haiti require shade, it is grown chiefly in wooded areas in the mountains.

Cotton which is second in importance is produced on a perennial shrub. When untrimmed it may grow to be 8 or 10 feet high.

Logwood or dye wood (*Haematoxylon campechianum* L.) locally known as "campêche" is also an important export. This tree was introduced probably from Yucatan many years ago and now grows wild on the plains and the foot hills. It is the chief honey plant of Haiti. Gaiac and mahogany are other important trees.

Other crops somewhat in order of their importance are: sugar cane (also largely surviving from French cultivation, though lately several new varieties of cane have been brought from Porto-Rico), tobacco, rice, red beans, corn (field variety only), sisal, manioc, peanuts, sesame, petit-mil (a native variety of grain sorghum resembling shallu), and feterita.

Among the fruits, should be mentioned several varieties of mangos, papayas, quéneppes (*Melicocca bijuga*), mombins (*Spondias mombin*), citrus, including limes, oranges and grape fruits, cacao, apples and peaches (the latter two of a very poor quality and only in the higher altitudes), pine-apples, guavas, caymites, corosols, cocoanuts, cashew, bananas, plantains, avocadoes, and abricots (*Mammea americana*).

Of vegetables there are many, but string beans, carrots, cabbage, beets, tomatoes, sweet potatoes, yams, very small Irish potatoes, French

melons (musk melons), water melons (of poor quality), malanga, bread-fruit, peppers, beets, radishes, turnips, lettuce and mirlitons (*Sechium edule*), are the most important.

There is therefore a mingling of temperate zone and tropical vegetation, particularly at the higher altitudes. One also finds a mingling of insects of these two regions.

A List of the More Important Insect Pests by Crops.

Coffee Insects

Apate franscisca Fab. (Bostrichidae)—Coffee stem borer.

Cremon repentinus Rehn., Mss. species (Gryllidae)—A coffee cricket which deposits its eggs in a series of punctures in the new growth. The branches are so weakened that they may break when loaded with berries.

Leucoptera coffeella Stainton (Tineidae)—Coffee leaf miner. Not important.

Loberus insularis (?)—A small Cryptophagid beetle found working in the dried beans both in storage and on the bushes.

Anurogryllus muticus DeGeer and *Orocharis similis* Walk. are common crickets which eat the foliage.

Coccus viridis—Green coffee scale, the most serious scale insect of coffee.

Aleurocanthus woglumi Ashby—A black Aleyrodid common in poor coffee regions as at Pétionville.

Lasioderma serricornis Fab.—A Dermestid found damaging stored coffee at Jacmel.

Saissetia hemisphaerica Targ. (Coccidae)—Brown coffee scale.

Pseudicoccus nipae Mask. (Coccidae)—White coffee scale.

Aphids on roots—Identity unknown.

Cotton Insects.

Alabama argillacea Hub. (Noctuidae)—Outbreaks July to December.

Anomis doctorium Dyar (Noctuidae)—Similar to the above but less common.

Platyedra gossypiella Saunders (Gelechiidae)—Pink boll worm.—Causes little damage to native cotton but attacks severely the exotic imported varieties, such as Sea-Island, Meade, Pima and Upland.

Dysdercus andreae Linn. (Pyrrhcorridae)—Cotton stainer.—The most serious cotton insect of Haiti.

Aphis gossypii Glover—The cotton aphid—Very abundant and particularly serious on young cotton plants.

Hemichionaspis minor Maskell—Cotton scale—Present on most old cotton plants but probably does little damage.

Artipus psittacinus Gyllenhall—Cotton leaf chafer, small green scarab present in considerable numbers on many plants but doing little perceptible damage.

Nezara viridula Linn.—A fairly common Pentatomid. Feeds on young bolls and provides entrance for boll rot diseases.

Phyllophaga hogardi Blanch. (Scarabaeidae)—The common white grub of Haiti but not particularly serious on cotton.

Prodenia ornithogalli Guenée (Noctuidae)—Cotton cut worm or yellow striped Army worm—Sometimes goes from such weeds as *Boerhaavia erechtea* to cotton foliage and damages the foliage.

Pyroderces rileyi Wlsn. (Cosmopterygidae)—and *Loberus sp.* are cotton scavengers found in numbers in bolls injured by cryptogamic diseases. Also in insect excrement on other plants.

Solenopsis geminata Fabr., *D. pyramicus niger* Pergande, *Paratrechina longicornis* Latr. and *Monomorium destructor* Jerd are species of ants determined by Dr. M. R. Smith from cotton plants and other crops.

Nasutitermes spp.—Cotton termites which feed upon old stalks, roots and dropped bolls.

SUGAR CANE. (Varieties Native, Uba and P. O. J.)

Diatraea saccharalis Fab. (Crambidae)—The sugar cane moth borer is known to be abundant in only one field of P. O. J. cane.

Calisto pulchella Lathy (Satyridae)—The Sugar cane leaf worm.—Of little consequence.

Prenes nero Fab. (Hesperidae)—Not abundant.

Mocis repanda Fab. (Noctuidae)—Sugar cane looper. Sometimes present as an outbreak such as occurred in the Hasco fields, 1928.

Prepodes quadrivittatus Oliv. (Cucurlionidae)—Not common.

Laphygma frugiperda Sm. and A.—Damages young cane sometimes.

Pseudococcus calceolariae Mask.—A mealy bug occurring under the leaf sheaths. Common.

Aphis maidis Fitch—Common on young cane. Said to be the transmitters of sugar cane mosaic which is a serious cane disease.

Lachnosterna hogardi Blanch., *Lygyrus ebenus* De Geer, and *Strataegus quadrifoveatus* P. de B. are white grubs which do serious damage to the roots of cane.

Pseudococcus sacchari Ckll., the pink stalk mealy bug which occurs under leaf sheaths of cane, particularly of stalks which have gone down.

TOBACCO INSECTS.

Phthorimaea operculella Zeller (Gelechiidae)—Tobacco leaf miner—A very serious pest of young plants, particularly in the beds and when transplanted.

Psara periusalia Walk (Gelechiidae)—Tobacco leaf roller—Makes a tent of two leaves, feeds on the leaf surface within. Serious on young plants.

Protoparce sexta Johannsen (Sphingidae)—Tobacco horn worm—Very abundant and destructive.

Epitrix parvula Fab. *E. cucumeris* Harris and *Systena basalis* Duval are flea beetles (Chrysomelidae) which are very damaging at times to young plants.

Nezara viridula Linn. (Pentatomidae)—The pumpkin bug—is said to cause wilting of the buds.

Prodenia ornithogalli Guenée and *Feltia annexa* Treit. (Noctuidae) are tobacco cutworms particularly damaging to young plants.

Solenopsis geminata Fabr. (Formicidae)—These ants are particularly damaging to young plants in the beds. They also carry off newly sown seed.

CORN AND FETERITA

Laphygma frugiperda S. & A. (Noctuidae)—The Fall army worm—is very common and feeds on the hearts of these plants causing the rag worm injury.

Agrotis sp., a cut worm, is common on young plants, cutting them off.

Sitophilus oryzae L.—Rice weevil—and *Calandra granaria* L.—the common granary weevil—attack stored corn. The former is much more common than the latter.

Tribolium confusum Linn.—Confused flour beetle (Tenebrionidae)—is very abundant in stored grain of all kinds.

Heliothis obsoleta Fabr.—The corn ear worm—does not cause very great damage since the variety of corn grown is a hard flint type. It does not attack cotton bolls nor tomatoes as in the States.

Aphis maidis Fitch.—Corn leaf aphid—is very common on young plants.

Peregrinus maidis Ashmead (Fulgoridae)—occurs in great numbers on the young plants and *Cicadula maidis* De L. & W. (Cicadellidae) also in lesser number is found on the leaves of the plants.

Polistes crinitis Fabr. and *P. major* P. de B. are common. They gnaw the surface of the leaves and feed on the sweetish exuding sap.

SWEET POTATO INSECTS

Cylas formicarius Fabr. (Curculionidae)—The Sweet potato weevil—is present in practically all fields in Haiti and causes a bitter or spoiled taste in tubers attacked.

Euscepes batatae Waterhouse is another weevil which does the same kind of injury as Cylas but it is less important.

BANANA

Cosmopolites sordidus Germar (Curculionidae)—Banana root borer.—Widely distributed and serious.

PAPAYA

Aulacaspis pentagona Targ.—The West Indian peach scale—is very common, the older trees which are sometimes heavily encrusted with the scale.

Erinnyis spp. (Sphingidae)—Papaya leaf worms—are common but never serious. They are controlled by a Braconid parasite, *Apanteles americanus* Lep.

Prepodes 4-vittatus Oliv. (Curculionidae)—occurs particularly on young plants, but is rarely serious.

Toxotrypana curvicauda Gerst—Papaya fruit fly and *Anastrepha fraterculus* Wied (Trypetidae) which is the West Indian fruit fly—both attack the fruit of papaya. The former is serious in some localities, the latter is most common on mangoes, mombins and cirouelles.

ORNAMENTAL PLANTS

Cannas are attacked by a skipper, *Calpodes ethlius* Cramer, which severely damages the foliage. The greenish larvae turn over the margin of the leaves beneath which they feed and pupate. The eggs were found to be highly parasited by *Trichogramma minutum* Riley.

HOUSEHOLD INSECTS

Mosquitoes are abundant at various seasons of the year, particularly during the rainy season and in swampy localities. The common tropical house mosquito, *Culex quinquefasciatus* Say is perhaps the most abundant one throughout the year and is said to be the one responsible for Elephantiasis of which many cases occur.

Aedes aegypti Linn. is also very common but yellow fever has long since been banished. Dengue is very common particularly with new-comers to the island.

Aedes sollicitans Walk. and *A. taeniorhynchus* Wied. are common in homes.

Anopheles albimanus Wied. is the most common malarial mosquito though *A. grabhami* Theob. is also common. Malaria is very common, but adult Anopheles mosquitoes are quite uncommon.

A very small Oscinid fly, *Hippelates flavipes* Loew, is very annoying to people. The flies buzz very close to one's face but they do not bite.

Culicoides furens Poey, a biting Chironomid, is abundant and disturbing, particularly in moist grassy places.

House flies are singularly uncommon in Haiti. They were found breeding in piles of fermenting coffee hulls and in pulp from a sisal decorticating plant.

Psychoda albipuncta Will.—A large Psychodid fly—is common in bathrooms and was found breeding in great numbers in a septic tank.

Bed bugs are very common indeed and strangely go largely unfought by the natives.

Fleas on dogs are exceedingly common.

At Kenscoff the problem of the chigoe fleas is very important. Many of the peasants have their feet infested with fleas.

Termites are very serious pests in houses and on any kind of wood structures. Wolcott (1924) lists *Cryptotermes brevis* Walker as the common one in houses; *Nasutitermes morio* Lat. makes the large nests in trees and *N. pallidiceps* Banks attacks cane in the field. The numbers of winged termites which swarm out from residences during the first rains of August and September are almost unbelievable. It indicates something of the size of the colony of termites in one's home. Floors in many homes and public buildings such as the U. S. Field Hospital are kept heavily oiled to prevent termite attacks.

Cockroaches are very bothersome indeed in homes. The large American cockroach, *Periplaneta americana* Linn. is one of the most common and a smaller form, resembling the German roach which is *Supella supellectilum* Serv. is also abundant. Adults of another cockroach, *Epilampsa sabulosa* Walk. are common at lights in August and September.

Ants however are the most common of all the household pests, one or more species of Solenopsis being most common.

GARDEN INSECTS

A Pyralid leaf skeletonizer, *Pilocrocis tripunctata* Fab., is the most serious pest of beets in Haiti. Another member of this family, the pumpkin leaf worm, *Margaronia hyalinata* Linn., often seriously defoliates pumpkins, squashes and muskmelons during the winter months.

The southern cabbage looper, *Autographa* (*Plusia*) *simplex* is by far the worst cabbage pest in Haiti and if uncontrolled generally ruins the foliage.

Plant lice (*Aphis gossypii* Glover) are particularly severe on artichokes. The plants may be killed by them and leaves are often seen to be wilting because of their attacks.

Phthorimaea lycopersicella Bush. damages the foliage of tomatoes severely.

Phthia picta Drury (Coreidae)—taken feeding on tomato fruit.

Fundella sp.—A bean twig borer which bores into the stems from the tips, stopping growth. Very common and apparently new according to Heinrich.

MISCELLANEOUS INSECTS

A large Cerambycid beetle, *Stenodontes exsertus* Oliv., more spectacular than injurious, occasionally occurs in the decaying trunks of kapok or mapou trees (*Ceiba pentandra*). The leaves of this tree are annually eaten by *Eulepidotis modestula* N. S., probably not by May beetles as Wolcott suspected (1928, p. 22).

The Palm leaf skeletonizer, *Homaledra saballela* Cham has recently been found to be a serious enemy of the latanye palms in Haiti. The damage to the foliage may be sufficiently severe to kill the trees.

Aspidiotus destructor Sig., Palm scale, a serious pest of palms, particularly coconut.

A species of *Empoasca*, determined as a new species by Dr. D. M. De Long, was found to be responsible for a destructive yellow disease of all varieties of beans in Haiti. (Smith and Barker, 1930).

Pseudococcus nipae Mask.—Coconut mealy bug—Especially serious on young royal palms.

Chrysomphalus aonidum Linn.—Florida red scale—Serious on all palms.

Aulacaspis pentagona Targ. is a common semi-burrowing scale very destructive to a large leafed porch vine (*Pipex pentatum*).

A species of Mirid, determined as *Cyrtopeltis tenuis* Reut. by Dr. H. K. Knight, is an important pest of tomatoes.

Two species of bee moths occur in Haiti; the common one, *Galleria melonella* Linn., and a smaller wax moth, *Corcyra cephalonica* Stt. These two insects are very destructive to combs and weak colonies.

A small Tineid case bearer, *Tinea uterella* Wlsm., is common on the plastered walls of homes. The larvae make flat gray silken oblong sacks which are covered with sand. They feed upon insect remains but probably do no damage.

The tips of the branches of manioc are often severely damaged during February by a Sapromyzid fly, *Lonchaea chalybea* Wied.

Corythaica monacha Stahl. (Tingidae)—The egg-plant lace bug is the most common and most destructive of egg-plant insects.

Psara bipunctalis Fabr. is a webworm, which in larval appearance and habits closely resembles the garden webworm of the U. S. It is common each year on some weeds (*Amaranthus* sp.)

Megachile multidens Fox is a leaf cutting bee very common in buildings.

The Haitian insect fauna is particularly rich in species of Sphingidae, *Celario lineata* Fab., the white-lined Sphinx is particularly abundant. It feeds most commonly on *Boerhaavia*, a species of weed.

Some Serious Tropical and Subtropical Insect Pests not Known to Occur in Haiti

The Cotton boll weevil, *Anthonomus grandis*, while in Cuba only 45 miles away at the nearest points, is not yet in Haiti.

The Mediterranean fruit fly, *Ceratitis capitata* Wied, has never been recorded in Haiti and it has not been taken there so far as the records show.

Stephanoderes coffeae, the serious Brazilian coffee pest is not known to occur in Haiti.

A few specimens of the common Chinch bug were collected in a clump of a common grass in 1928, but the species is without economic importance.

References

Smith, Roger C. and H. D. Barker. Observations on the "Yellows" disease of beans and related plants in Haiti, Jour. Econ. Ent. 1930. 23: 842-847.

Smith, Rogers C., Bees and Beekeeping in sunny Haiti, Amer. Bee Jour. 1930. 70: 130-131, 184-185.

Wheeler, William M. and W. M. Mann. The Ants of Haiti, Bul. Amer. Mus. Nat. Hist., 1921, pp. 33.

Wolcott, George N. Entomologie d'Haiti, Service Technique, Port-au-Prince 1927, 440 pp., 133 figs.

WOLCOTT, GEORGE N. Increase of Insect Transmitted Plant Disease and Insect Damage Through Weed Destruction in Tropical Agriculture. Ecology, 1928, pp. 461–466.

WOLCOTT, GEORGE N. Haitian cotton and the Pink Boll Worm, Bul. Ent. Research. 1928. 18: 79-82.

WOLCOTT, GEORGE N. The May beetles of Haiti. Proc. Ent. Soc. Wash. 1928. 30:21-29.

WOLCOTT, GEORGE N. Notes on the Life History of *Exopthalmus quadrivittatus* Oliv., Proc. Ent. Soc. Wash., 1929, 31: 21.

WOODRING, WENDELL P., JOHN S. BROWN and WILBUR S. BURBANK, Geology of the Republic of Haiti, Bul. Dept. of Public Works, 1924, 631 pp.

SOME PHYSICAL PROPERTIES OF CERTAIN DORMANT OIL EMULSION-SULPHUR COMBINATIONS[1]

By M. D. FARRAR and M. A. SMITH

ABSTRACT

A recent development in a dormant tree spray is described. The spray combines a type of oil emulsion and Flotation sulphur in such a manner as to give an efficient combination spray for San Jose scale and peach leaf curl. The methods of mixing and the physical properties of the combination are discussed.

In some peach growing sections growers have become dissatisfied with liquid lime sulphur as a spray material for the control of San Jose scale and peach leaf curl. Their objections are based on its low efficiency of scale control and on the difficulty of handling due to its corrosive action. As a result, such combinations as Bordeaux oil emulsion, boiled lubricating oil emulsion with Bordeaux, and miscible oils combined with Bordeaux have come into wide use.

With the increasing use of wettable sulphurs, combinations of sulphur and oil have been developed for use in dormant sprays. During the course of several years' experiments at the Illinois Agricultural Experiment Station oil emulsions have been combined with sulphur for use as dormant sprays. Such combinations have been found to possess excellent insecticidal and fungicidal properties. They have been extremely easy to handle and have been used with entire safety on peaches, apples, plums, and small fruits. The present paper is a summary of studies made of the physical properties of some of the oil emulsion-sulphur combinations used as dormant sprays.

MATERIALS AND METHODS. In these studies formula L-21 was the chief oil emulsion used (Pl. 34, fig. 1.). L-21 is an experimental formula con-

[1]Joint paper.

Cooperative investigation between the Crop Protection Institute, the State Natural History Survey and the Department of Horticulture, University of Illinois, Urbana, Ill. This study has been made possible with funds supplied by the Standard Oil Company of Indiana and The Koppers Company of Pittsburgh, Pa.

taining an 83 viscosity (100°F.) lubricating oil emulsified with a gum. In addition to L-21, several types of commercial emulsions were used which contained various emulsifiers.

The sulphurs used were Flotation, ground clemental, sublimed, precipitated, and Ialine. In the experiments described in this paper the concentration of sulphur was made on an actual sulphur basis.

Flotation is a precipitated sulphur obtained in the manufactured gas industry from a process known as liquid purification. This process has been fully described by Sperr (7, 8) and Sauchelli (5).

When first obtained from the filter press it contains some soluble impurities and is known as unwashed Flotation sulphur. After most of these salts have been removed by washing it is known as washed Flotation sulphur. When washed Flotation sulphur is subjected to additional washing all of the soluble salts may be removed, leaving a pure sulphur paste. Such a sulphur has been designated in this paper as extra washed Flotation sulphur.

The ground elemental sulphur used was of a standard commercial grade.

The sublimed sulphur was prepared in the laboratory by the usual methods.

The precipitated sulphur used was obtained by treating lime sulphur solution with an acid.

The "Ialine" sulphur is a commercial product whose particles are in an extremely fine state of division.

After dilution of the different oil emulsion-sulphur combinations, microscopic mounts were prepared and measurements made. A microscopic examination was made of diluted samples of the oil emulsion used and measurements were made at frequent intervals. This was done to detect any possible change in the physical condition of the emulsion.

Experiments on the combination of oil emulsions with sulphur have indicated that a relation exists between the physical properties of the mixture and the method of combining the stock materials.

Such a combination contains an insoluble oil phase, water, water soluble emulsifier, and wettable sulphur. To bring such a combination into a stock of uniform stability, physical orientation of each material must take place. This adjustment conforms to theories of emulsification as expressed by Bancroft (1), Haskins (4), Finkle (3) in which the ingredients assume phases or interphases according to the surface tension between each ingredient. This combination is the oil enclosed type; the emulsifier assuming the interfacial position between the water and the oil. When the water, emulsifier, and sulphur are combined, before

mixing with the oil, and the mixture emulsified, the sulphur disperses into the water phase with only a very small quantity entering into the emulsifier interface. In such a combination the sulphur gradually settles to the bottom of the container in storage.

When a stock oil emulsion and sulphur are combined, an entirely different type of mixture results. In this method the sulphur is brought into intimate contact with the emulsifier which apparently attracts the sulphur. As a result, there is a union between the sulphur and the oil droplet that is not easily broken by dilution. When such a combination is diluted, many of the oil droplets carry particles of sulphur on their surfaces.

There is apparently a very important relation between the method of combining the oil emulsion and the sulphur, the relative size of the oil droplets, and the percentage of such oil droplets carrying sulphur. A typical set of such relations is expressed in Table 1.

TABLE 1. THE EFFECT ON THE PHYSICAL PROPERTIES OF AN OIL EMULSION-SULPHUR COMBINATION WHEN THE CONCENTRATION OF WATER IS VARIED

Parts by weight of			Average diameter in microns of oil droplets	Per cent of oil droplets carrying sulphur particles
Emulsion	Flotation sulphur	Water		
24	16	0.0	8.1	90.0
24	16	12.0	5.0	67.0
24	16	24.0	3.8	39.0
24	16	48.0	3.4	28.0
24	16	960.0	3.2	23.0
24	0	0	2.6	0.0

From Table 1 it is apparent that when the oil emulsion and sulphur are combined directly, without the addition of water, there is an increase in the size of the oil droplets, a high percentage of which carry sulphur. The size of the oil droplets and the percentage of droplets carrying sulphur decrease as more water is added to the combination. .

It is believed that the addition of water suspends the sulphur in such a manner as to increase the distance between the sulphur particle and the emulsifier interface. This so weakens the bond of attraction between the sulphur particles and the emulsifier that there is little attachment between them.

Experiments were carried on to test the influence of various emulsifiers on oil-sulphur combinations. Typical commercial emulsions were used. The results of these tests appear in Table 2.

The following table shows a striking relationship between the type of emulsifier and its influence on the combination. Emulsions made with a gum emulsifier act similarly. The addition of Flotation sulphur to this type of emulsion results in the attachment of large numbers of sulphur

particles to the oil droplets. Oil droplets thus coated with sulphur tend to coalesce, increasing their size. Emulsions made with emulsifiers such as potassium fish oil soap, potassium caseinate, and petroleum soaps give a very low to negative attachment of sulphur particles to the oil and there is no change in the average size of the oil droplets.

TABLE 2. PHYSICAL CHARACTERS OF CERTAIN PROPRIETARY EMULSIONS WHEN COMBINED WITH FLOTATION SULPHUR

Type of emulsifier	Ave. diameter in microns of oil droplets	Ave. diameter in microns of oil droplets when combined with Flotation sulphur	Percentage of oil droplets carrying sulphur particles
Gum	8.6	18.2	97.0
Gum	6.5	13.0	80.0
Potassium fish oil soap	4.7	5.5	10.0
Potassium caseinate	5.0	3.7	8.0
Potassium caseinate	2.5	Not determined	Not determined
Pertoleum soap	1.0	Not determined	Not determined

A study was next made of the influence of sulphurs of different particle size on the size of oil droplets and the attachment of sulphur to them. These results appear in Table 3.

TABLE 3. THE INFLUENCE OF SULPHUR PARTICLE SIZE ON OIL-EMULSION SULPHUR COMBINATIONS

Type of sulphur	Particle size in microns	Influence on size of oil droplets	Percentage of oil droplets carrying sulphur particles
Ialine	1–3	None	15
Sublimed	1–3	None	1
Flotation	3–5	Large increase in size	95
Precipitated from lime sulphur by HCl	5–10	None	1
300 mesh ground sulphur	10–50	None	1
300 mesh ground sulphur and wetting agent	10–50	None	1

The results in Table 3 show that there is no direct correlation between the size of the sulphur particle, the size of the oil droplets, or the attachment of sulphur to them.

The fineness of the sulphur particles was not a factor in bringing about adherence of Flotation sulphur to the oil droplets. Ialine and sublimed sulphurs exhibited low adhering qualities although finer than Flotation sulphur.

It was believed that the small per cent of soluble electrolytic impurities contained in Flotation sulphur might exert some influence on the attachment of sulphur particles to the oil droplets and on the increase in size of the oil droplets. An experiment was carried on to test this view.

Flotation sulphur containing soluble electrolytic impurities in varying amounts was mixed with L-21 oil emulsion and each mixture examined microscopically. The results of these tests are given in Table 4.

TABLE 4. PHYSICAL CHANGES PRODUCED IN AN OIL EMULSION-FLOTATION SULPHUR COMBINATION FOLLOWING THE REMOVAL OF SOLUBLE IMPURITIES

No.	Stock emulsion	Per cent of electrolytic impurities	Ave. diameter in microns of oil droplets	Percentage of oil droplets carrying sulphur particles
1	L-21	0	3.0	None
2	L-21 and extra washed Flotation sulphur	Trace	4.7	11.0
3	L-21 and washed Flotation sulphur	.25–1.0	9.4	90.0
4	L-21 and unwashed Flotation sulphur	4–7	11.4	95.0

In Table 4, stock emulsions numbers 2, 3, and 4 show the role played by soluble electrolytic salts contained in Flotation sulphur; its relation to the size of oil droplets and the percentage of oil droplets carrying sulphur (Pl. 34, figs. 2, 3, 4).

The results of unpublished data of the writers show that the electrolytes as found in Flotation sulphur are of little fungicidal value. Apparently their value is physical, i.e. they impart to the Flotation sulphur the property of adherence to the oil droplets.

Experiments have shown that the amount of soluble salts contained in unwashed Flotation sulphur may cause injury to plant tissue when such sulphur is used at a concentration of over 2 pounds to 50 gallons of water (6). Although stock emulsion No. 4 exhibits slightly better physical properties than No. 3, the toxicity of this combination to plant tissue would make it unsafe if applied following the dormant period.

Three years' experiments of the writers have shown that stock emulsion No. 3 made with washed Flotation sulphur possesses high insecticidal and fungicidal properties and this combination has been applied with safety in both dormant and delayed dormant applications.

An experiment was next carried on to determine what effect larger quantities of sulphur would have on the physical properties of an oil emulsion-sulphur combination. The oil emulsion was mixed with the sulphur in varying quantities, water added, and microscopic examination made of each. The results of these tests appear in Table 5.

TABLE 5. THE EFFECT ON THE PHYSICAL PROPERTIES OF AN OIL EMULSION-FLOTATION SULPHUR COMBINATION WHEN THE CONCENTRATION OF SULPHUR IS VARIED

Pounds of sulphur to 50 gal.	0	1	2	3	4	6	8	16
Average diameter in microns of oil droplets	3.5	9.4	9.2	8.1	9.8	10.6	14.8	19.8
Percentage of oil droplets carrying sulphur particles	0	8.0	40.0	80.0	85.0	90.0	90.0	90.0

As noted in Table 5, the percentage of oil droplets carrying sulphur particles varied greatly when the sulphur was used at the rate of one and two pounds of sulphur respectively to 50 gallons of water. The percentage of oil droplets carrying sulphur particles varied slightly when sulphur was used at 3 pounds and above. The average diameter of the oil droplets remained practically the same at concentrations of 1, 2, 3, 4, and 6 pounds of sulphur to 50 gallons. When the concentration of sulphur exceeded 6 pounds, there was an even greater increase in size of the oil droplets.

In 1928, 1929, and 1930, experiments showed that 4 to 6 pounds of Flotation sulphur when combined with L-21 gave satisfactory control of peach leaf curl and San Jose scale.

The efficiency of this combination is apparently correlated with its physical properties. In the field, a type of coverage is obtained whereby the distribution of oil and sulphur is uniform and in very intimate contact with the host. (Plate 35) After the emulsion breaks, there is a close association of oil and sulphur. This type of coverage furnishes a protection not obtainable by other dormant spray materials.

Conclusions

1. When L-21 oil emulsion and sulphur were combined directly the physical properties were superior to a combination in which excess water was added at the time of mixing.

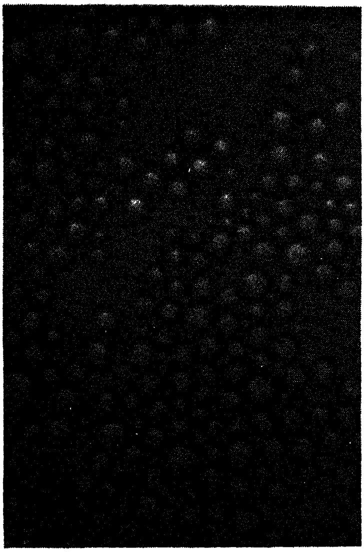
2. Oils emulsified with a gum in combination with sulphurs were superior physically to those emulsified with potassium fish oil soap, potassium caseinate, and petroleum soaps.

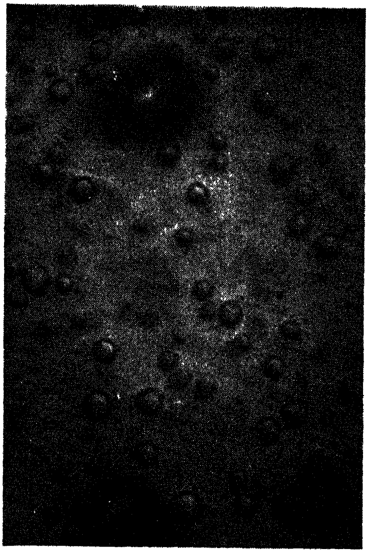
3. Sulphur particle size was shown to be a minor factor in the combinations of oil emulsion and sulphur used.

4. Flotation sulphur at various stages in its purification contains electrolytes in small quantities. These electrolytes were found to exert a very important influence when L-21 and Flotation sulphur were combined.

5. Laboratory experiments indicated that the most desirable physical properties of the combination were obtained when from 4 to 6 pounds of Flotation sulphur were combined with 1½ gallons of L-21 and diluted in 50 gallons of water.

6. Three years' field data showed that L-21, when used at 1½ gallons and Flotation sulphur (dry basis) at 5 pounds to 50 gallons of water, was a highly efficient combination for the control of San Jose scale and peach leaf curl.





1, L-21 oil emulsion; *2*. L-21 oil emulsion combined with extra washed Flotation sulphur; *3*. L-21 oil emulsion combined with washed Flotation sulphur; *4*. L-21 oil emulsion combined with unwashed Flotation sulphur. Photomicrographs x 800.

Photograph of peach twigs sprayed with (*a*) L-21 oil emulsion; (*b*) L-21 oil emulsion and extra washed Flotation sulphur; (*c*) L-21 oil emulsion and washed Flotation sulphur; (*d*) L-21 oil emulsion and unwashed Flotation sulphur (Natural size).

BIBLIOGRAPHY

1. BANCROFT, W. P. The theory of emulsification. Jour. Phys. Chem. 19: 275–309. 1915.
2. CUTRIGHT, C. R. Combination insecticide and fungicide sprays for dormant and delayed dormant spraying in Ohio. Bimonthly Bull. 14:42–44, Ohio Agr. Exp. Sta. 1929.
3. FINKLE, P.; DRAPER, H. D.; HILDEBRAND, J. H. The theory of emulsification. Jour. Amer. Chem. Soc. *45:* 2780–2788. 1923.
4. HASKINS, W. D.; DAVIS, E. C. H.; CLARK, G. L. Orientation of molecules in the surface of liquids, the energy relations of surfaces, solubility, adsorption, emulsification, molecular association, and the effect of acids and bases on interfacial tension. Jour. Amer. Chem. Soc. *39:* 541–596. 1917.
5. SAUCHELLI, V. A new by-product sulfur for agriculture. Chemical Markets 24:3–4. March, 1929.
6. SMITH, M. A. The control of certain fruit diseases with flotation sulphurs. Phytopathology 20: 535–553. 1930.
7. SPERR, F. W., JR. New methods of gas purification. Canadian Gas Association Proceedings. 1926.
8. ——— Gas purification in relation to coal sulfur. International Conference on Bituminous Coal. Vol. II, Nov. 1928.

DENSITIES OF MIXTURES OF AIR AND VARIOUS FUMIGANTS

By R. C. ROARK and O. A. NELSON, *Insecticide Division, Bureau of Chemistry and Soils, Washington, D. C.*

In order to judge the suitability of a compound for use as a fumigant, it is desirable to know certain of its properties. Among these are (1) toxicity to the pest to be destroyed, and (2) vapor pressure, from which an idea of the volatility can be obtained and the maximum quantity of material that can exist in vapor form in a definite volume can be calculated. These two factors have been considered in former publications.[1] There is another property which is of importance, inasmuch as it influences the distribution of the fumigant during application; i.e., the density of the vapor evolved by the fumigant. The present paper will consider this property of the compounds most frequently used.

It is a more or less common practice to speak of the vapor of a fumigant as being heavier or lighter than air, and when figures are given to illustrate the point, they are usually simply calculated from the molecu-

[1]Cotton and Roark, J. Econ. Ent. 20: 636–639, 1927; Ind. Eng. Chem. 20: 380–382, 1928; and 20: 805–806, 1928; Roark and Cotton, J. Econ. Ent. 21: 135–142, 1928; Ind. Eng. Chem. 20: 512–514, 1928; U. S. D. A. Tech. Bull. 162, March, 1930. Roark and Nelson, J. Econ. Ent. 22: 381–387, 1929. Nelson, Ind. Eng. Chem. 20: 1380–1382; and 1382–1384, 1928. Young and Nelson, Ind. Eng. Chem. 21: 321–322, 1929.

lar weight of the compound, and hence refer to standard conditions of 760 mm. of mercury pressure and 0°C. Such standard conditions are, of course, possible only for gaseous fumigants. A liquid or solid fumigant when used at a temperature below its boiling point evolves vapor which mixes with the air above and saturates it if conditions are favorable. This saturated air generally differs in density from air itself, and tends to rise or fall through the surrounding air as the case may be. This tendency to rise or fall of course varies as the density of the saturated air approaches or departs from that of pure air. Thus, the tendency of carbon disulfide vapor to fall in a fumigating chamber is not to be judged by the figure 2.62 which is its theoretical density under impossible "normal" conditions, but by the figure 1.76 which is the density (referred to air) of air saturated with carbon disulfide at 25°C.

It is obvious that in order to calculate the weight of a unit volume of any mixture of fumigant and air it is necessary only to add together the weight of air and the weight of fumigant contained in that volume.

A consideration of the law of partial pressures leads to the following formula for the case of two gases,

$$D_t^p = \frac{M}{V} = \frac{P-p}{P} D^1 + \frac{p}{P} D_2 \frac{273}{273+t}$$

in which D_1 and D_2 represent the theoretical densities of the two individual gases under "normal" conditions (and hence derivable from the molecular weights), D_t^p represents the density of the mixture under the actual conditions of pressure (P) and temperature (t° C.), and p represents the vapor pressure of the fumigant at t°.

Because most recommendations for fumigation quote the dosage in pounds per 1,000 cubic feet, and most fumigations are carried out at about 25° C. (77° F.), these conditions have been adopted as a basis for the calculations reported here. For these conditions, the formula just given reduces to

$$\text{Pounds per 1,000 cubic feet} = 73.95 + \frac{p(M-29.0)}{298}$$

in which p is the number of mm. of mercury pressure and M is the molecular weight of fumigant.

Table 1 gives the density thus calculated and in addition the specific gravity of each mixture in relation to air at 25° C. and 760 mm. pressure.

It will be observed that of the 28 compounds discussed only four give mixtures with air which have a density less than that of pure air, and of these four hydrocyanic acid is the only one commonly used as an insecticidal fumigant. (Statements to the effect that hydrocyanic acid

TABLE 1. DENSITIES AND SPECIFIC GRAVITIES OF SATURATED MIXTURES OF AIR AND FUMIGANTS

Compound	Formula	Mol. Wt.*	Vap. pres. mm. Hg. at 25°C.	Density (mass of 1,000 cu. ft. satd. mixt. at 760 mm. Hg. and 25°C. (77° F.)	Sp. gravity air=1 at (25° C. and 760 mm.)
			Mm. Hg.	*Pounds*	
Air			760	73.95	1.0000
Ammonia	NH_3	17.03	760	43.40	0.5868
Arsine	AsH_3	77.98	760	199.20	2.6937
sec.-Butyl formate	$HCO_2C_4H_9$	102.08	48.1	85.77	1.1598
Camphor	$C_{10}H_{16}O$	152.13	0.19	74.03	1.0011
Carbon dioxide	CO_2	44.00	760	112.20	1.5173
Carbon disulfide	CS_2	76.14	357.1	130.44	1.7638
Carbon monoxide	CO	28.00	760	71.40	.9655
Carbon tetrachloride	CCl_4	153.83	114.5	121.91	1.6486
Chloroform	$CHCl_3$	119.37	199.1	134.38	1.8172
Chloropicrin	CCl_3NO_2	164.38	23.8	84.73	1.1458
Cyanogen chloride	CNCl	61.47	760	156.96	2.1225
p-Dichlorobenzene	$C_6H_4Cl_2$	146.95	1.0	74.35	1.0054
Ethyl acetate	$CH_3CO_2C_2H_5$	88.06	92	92.20	1.2468
Ethylene	C_2H_4	28.03	760	71.48	.9665
Ethylene dichloride	$C_2H_4Cl_2$	98.94	79.6	92.60	1.2522
Ethylene oxide	C_2H_4O	44.03	760	112.28	1.5183
Ethyl formate	$HCO_2C_2H_5$	74.05	255.0	112.50	1.5212
Formaldehyde	HCHO	30.02	760	76.55	1.0351
Hydrocyanic acid	HCN	27.02	738.8	68.90	.9317
Isobutyl formate	$HCO_2C_4H_9$	102.08	43.5	84.51	1.1428
Isopropyl formate	$HCO_2C_3H_7$	88.06	138.5	101.37	1.3708
Methyl chloroacetate	$CH_2ClCO_2CH_3$	108.50	9.0	76.37	1.0327
Methyl formate	HCO_2CH_3	60.03	614.0	137.88	1.8645
Naphthalene	$C_{10}H_8$	128.06	0.10	73.98	1.0004
Nicotine	$C_{10}H_{14}N_2$	162.13	0.12	74.01	1.0008
n-Propyl formate	$HCO_2C_3H_7$	88.06	85.0	90.79	1.2277
Sulfur dioxide	SO_2	64.06	760	163.36	2.2091
Tetrachloroethane	$C_2H_2Cl_4$	167.84	6.4	76.93	1.0403

*Molecular weights calculated according to 1928 revision of atomic weights. (J. Am. Chem. Soc. 50, 615, 1928).

gas is heavier than air have been seen in entomological literature, but are obviously erroneous.) From this it may be seen that in the absence of air-mixing devices, it is generally preferable to apply a fumigant at the top of the chamber, so that the heavier vapors will fall and thereby be more evenly distributed.

THE CALIBRATION OF FLOW METERS FOR THE MEASUREMENT OF INSECTICIDE GASES

By Lyman C. Craig, *Department of Chemistry* and C. H. Richardson, *Department of Zoology and Entomology, Iowa State College, Ames, Iowa*

In determining the relative toxicity to insects of a number of nitrogen bases in the gaseous state, it became necessary to have several flow meters accurately calibrated for different rates of flow. Flow meters were used extensively during the World War for research on poisonous gases and since then have been widely employed for chemical investigations on gases. In the chemical literature[1] theoretical discussions concerning the type of flow meter best suited for each purpose, the approximate size and length of a capillary for a certain rate of flow and the limits of accuracy are given. However, on looking over this work it seemed that more specific directions for the calibration of flow meters would be well worth placing in the entomological literature.

The following discussion concerns the resistance-tube flow meter which is shown in figure 88, A. It consists essentially of a horizontal tube of suitable bore with a manometer tube attached and suspended vertically from it. Between the arms of the manometer tube at B, the horizontal tube is constricted permitting a rubber stopper pierced by a short length of capillary tubing to be snugly fitted. This capillary offers resistance to the flow of air through the horizontal tube causing a displacement of liquid in the manometer tube, the displacement being proportional to the rate of air flow. By using capillaries of various diameters widely different rates of flow may be obtained.

In calibrating the flow meter, the volume of gas passed per unit time is accurately determined for a certain difference in level on the manometer scale. The volume for rates of flow over twenty liters per hour is best measured by means of a standard clock meter, whereas rates under twenty liters can most accurately be determined by measuring the volume of water drawn from an aspirator bottle when the rate of flow is held constant. It was more difficult to maintain a constant rate of flow over a period of time than was first expected, but the set up shown in Figure 88 gave very satisfactory results. A similar apparatus has been in use for some time in the laboratory of Dr. R. M. Hixon, in the Department of Chemistry, Iowa State College.

The flow meter A should be well cleaned with cleaning solution so that drops of water will not adhere to the walls of the manometer arm and

[1]Benton, A. F. J. Ind. & Eng. Chem., 11, 623 (1919), Fuwa, T. and G. A. Shattuck, Ibid., 15, 230 (1923.)

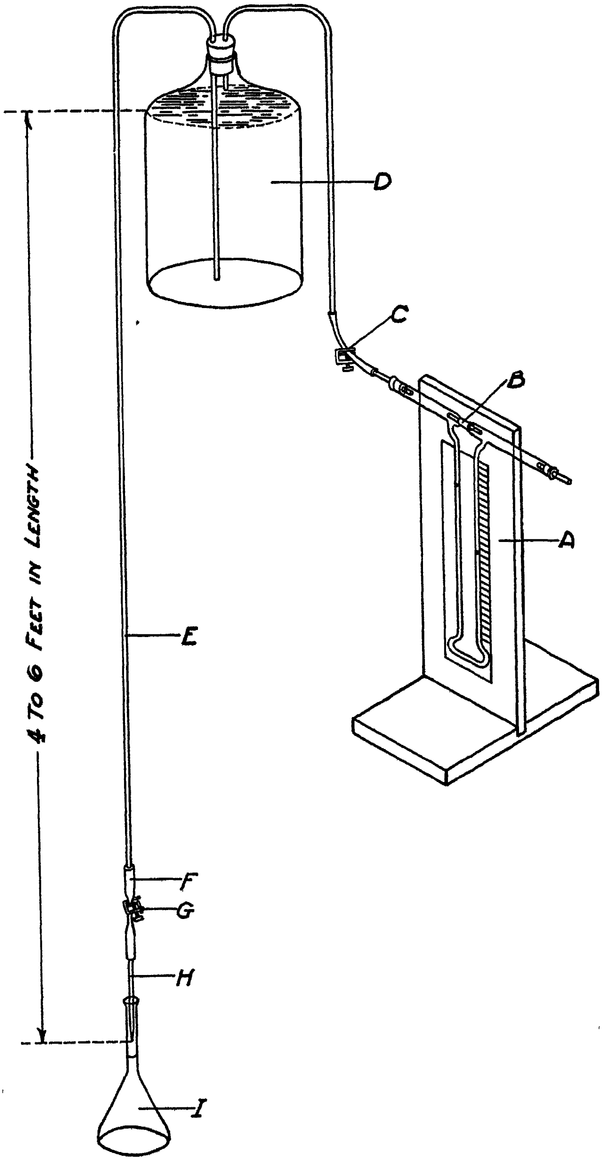


Fig. 88.—Resistance-tube flow meter.

thus give incorrect results. C and G are Hoffman clamps. D is a bottle of twenty to thirty liters capacity. The tubing E may be of rubber or glass. F is a piece of rubber tubing of small bore. I is a volumetric flask of convenient size. All connections must be air tight. This is very easily tested by filling D and E with water then opening G and closing C. In a few minutes water should cease to run from H. The opening at H, which consists of a piece of glass tubing, should be so small (approximately 1/8 inch in diameter) that the column of water will remain in E. The few minutes required for the establishment of equilibrium is caused by the air space in D which acts as a cushion. When the system is found to be air tight, C is opened and G is closed sufficiently to give the proper reading on the scale of A. It requires at least ten minutes for the reading on the scale of the flow meter to become constant. The time necessary to fill the volumetric flask I is taken with a stop watch, and is recorded as is also the reading on the scale of A. The volume per unit time is

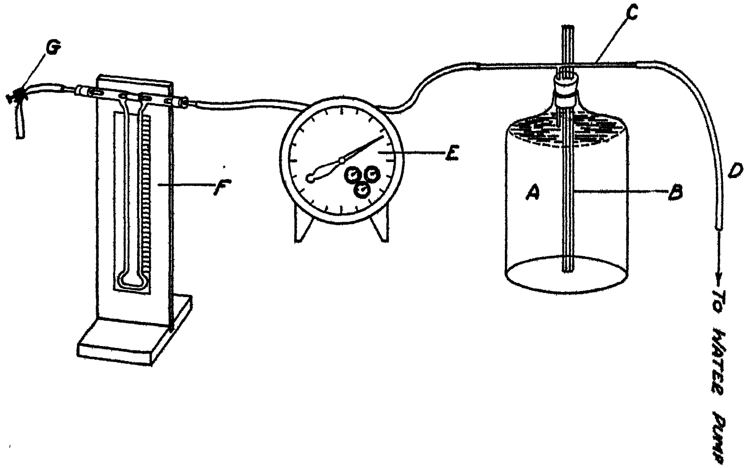


FIG. 89.—Set up for calibrating flow meters.

plotted against the flow meter reading. For most work on toxic gases the flow is given in liters per hour and the manometer reading in centimeters. Sufficient points are obtained to assure one of the correctness of the curve. The curve is almost a straight line when the orifice is small, but shows more curvature toward the lower end, as the size of the orifice increases. For an explanation of this see Benton (1).

When the set up is first used constant rates of flow are difficult to obtain. This must be due to the change of physical properties or acclimation of the walls of the rubber tubing directly under the clamp G.

This variability is less noticeable in a tube of small bore than in one of large bore. A negligible error is introduced if an average manometer reading is used provided the variation is not too great and equilibrium has been reached in D.

A convenient set up for calibrating flow meters with rates of flow greater than 20 liters per hour is shown in Figure 89. A is a bottle of approximately 20 liters capacity. An ordinary water pump is attached to the rubber hose D. E is a clock meter. The bottle A, should contain sufficient water so that its depth is somewhat greater than the height of the manometer arm of the flow meter F. When a strong flow of water is passing through the water pump the rate of bubbling from B will be faster than when a slow one is passing. If only one tube is used at B the rate of bubbling effects the pressure in the system. Several tubes help to overcome this effect. The rate of flow desired in the flow meter is regulated by means of the Hoffman clamp G.

Flow meters calibrated by either of the two methods outlined should not be in error over 1% if the proper range of the scale is used. For measuring different gases in biological work the flow meter is especially useful as it gives directly the rate of flow at any instant of time.

A SOIL-WASHING DEVICE FOR USE IN WIREWORM INVESTIGATIONS[1]

By F. H. SHIRCK, *Assistant Entomologist, Truck-Crop Insect Investigations, U. S. Bureau of Entomology*

ABSTRACT

An apparatus for separating eggs and young larvae of wireworms from field samples of soil by washing is described.

In connection with field studies on the egg and early larval stages of wireworms, some form of soil-washing apparatus was found necessary. The washer herein described was used during the past season, and proved satisfactory. This washer was patterned somewhat after the one described by Morris (*1*), but differs considerably in design, especially in being of somewhat simpler construction.

This washing apparatus consists of a rack containing a series of sieves, a hose equipped with an adjustable nozzle, and a small, funnel-shaped sieve with a removable bottom which is used in collecting the residues after washing is completed. Figure 90 gives the dimensions of the rack and shows details of its construction. The material used

[1]Approved for publication by Secretary of Agriculture, May 24, 1930.

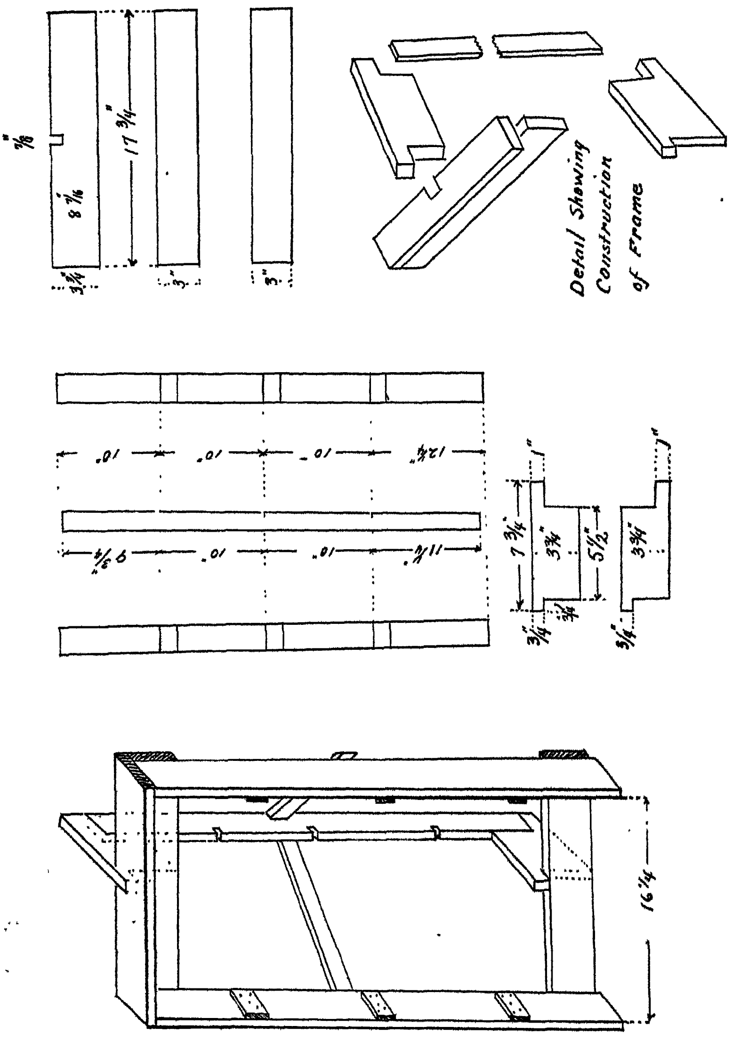
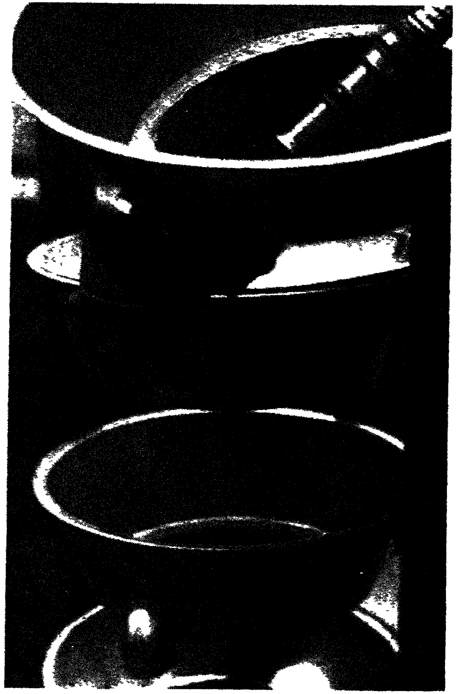


Fig. 90.—Soil Washer. Drawings showing construction of the rack in which sieves are held.

1. Assembled Washer. The small funnel for collecting residue is shown leaning against the drain pipe.



2. Showing method of removing residue from sieve.

was pine, three-fourths of an inch in thickness. Plate 36, 2 shows the assembled washer. The sieves were made by cutting the bottoms out of tin dishpans and soldering on brass screen cloth. The screen of the top sieve has ten meshes to the inch. Below this follow successively the 16-mesh, 30-mesh, 40-mesh, and 50-mesh sieves. Practically all of the eggs of the wireworms were retained in the 40-mesh screen. The 50-mesh sieve is required only for newly-hatched wireworms, some of which pass through the 40-mesh screen. The lowest pan has a solid bottom and serves to catch the wash water, which is led away through the drain.

The pans used in making the sieves were of two sizes. Pans numbered 2, 4, and 6 are each 4 inches deep and measure 16¼ inches (including ¾-inch flange) across the top. These pans fit into the three sets of supports on the frame and are held from tipping by inserting the flanges into the notches in the rear leg of the frame. Pans numbered 1, 3, and 5 are of smaller size, measuring 15½ inches in extreme width across the top and 2½ inches in depth. These smaller pans fit down inside the larger ones as shown in Plate 36, 1. When in position, the distance between the bottoms of the upper and lower pans in each pair is 1½ inches. To facilitate draining the pans short spouts or collars of nickel-plated brass 2 inches in diameter were soldered in openings near the bottom edge of pans 3, 4, and 5. Corks are used to stop these openings. It would be possible to use pans of uniform size by providing a support for each pan, and the spouts or collars could be of any metal that could be soldered to the tin. A funnel-shaped sieve with interchangeable screen bottoms is used to collect the residue from the pans.

The sample of soil to be washed is placed in the top sieve and the water is sprayed on it. Care must be taken not to splash the soil out of the sieves by use of too much pressure. The eggs and larvae of most wireworms, including two species of Limonius studied, will withstand without injury as much washing as is required to sieve the soil. The soil is carried through the two top screens without difficulty, but the finer meshes of the lower screens may become clogged. When a sieve clogs, draining can be started again by spraying water upward against the bottom. When the washing is completed, the material to be examined is collected by removing the drain cork (one is shown at "C," Plate 36, 1) and flushing the residue out through the opening into the funnel sieve as is shown in Plate 36, 2. When collecting the residue from pans 3 and 4 a 40-mesh screen is used in the bottom of the funnel and when collections are made from pan 5 a 50-mesh bottom is used. The funnel is swung back and forth a few times to shake out as much water as possible, after which the sieve bottom is removed and the material emptied from it

into a 2-ounce salve box for later examination. The residue is collected from pans 3, 4, and 5 through the opening fitted with the short spout. When the washer is in use these openings are tightly corked from the inside. No spouts are required on pans 1 and 2 as the coarse material collected in them can be readily examined and discarded at the time of washing. The spout on the bottom pan connects with a drain pipe which carries away the water.

This washer can be used out of doors wherever there is a hydrant to which the hose may be attached. It should be sheltered from high wind, as water may otherwise be blown out during passage from one screen to another. During calm weather, or with only a light breeze, water passes from one sieve to the other without splashing out.

One hundred and forty-four cubic inches, or about 8 pounds, of soil can be washed at one time. About six of such samples can be washed in an hour.

LITERATURE CITED

1. MORRIS, HUBERT M. A Method of Separating Insects and other Arthropods from Soil. Bull. Ent. Research, Vol. XIII, pt. 2, p. 197–200. London. 1928.

AN HUMIDITY APPARATUS[1]

By R. W. BURRELL, *Assistant Entomologist, Bureau of Entomology, United States Department of Agriculture*

ABSTRACT

A relatively simple and inexpensive apparatus is described which may be used in the production of desired high humidity in rearing rooms and incubator cellars.

It is generally recognized that the maintenance of a proper moisture content in the air is necessary for the most successful rearing of insects. Most of the parasitic insects handled at the Japanese Beetle Laboratory are soil-inhabiting forms, and require a high relative humidity. The apparatus to be described was devised to produce and maintain a relative humidity of 92 to 94 per cent in an incubator cellar used for rearing *Tiphia* cocoons. However, it is adaptable for use in nearly any situation requiring the production of humidity on a large scale. The principle utilized is the blowing of air over wet screens. The air is furnished by a fan which also, through a series of reduction gears, furnishes the power to rotate the screens in a pan of water. Small cups attached to the screens aid in keeping them thoroughly wet. This method of producing humidity provides humidified air which is the result of contact with wet

[1]Contribution No. 80. Research Laboratories, Moorestown, New Jersey.

surfaces and which does not contain fine floating droplets. The writer is greatly indebted to Mr. J. K. Holloway, whose valuable suggestions aided materially in the perfection of the apparatus.

The pan which holds the water is about 2 inches deep and is made of heavy metal provided with a flange to ensure maximum rigidity. The screens are disc shaped, 10 inches in diameter, and are cut from heavy galvanized screening, four meshes to the inch. They offer a large amount of evaporative surface with a minimum of resistance to the free passage of air through and around them. The number of screens may be variable but 16 were used in the apparatus described. The screens are mounted on a threaded brass shaft one-half an inch in diameter, are separated by small blocks of wood half an inch thick, and are firmly clamped in place by means of a nut at either end. The shaft rotates in ball bearings to provide a minimum of friction and reduce the strain on the driving motor. The small bearings used in Ford generators are an ideal size, and are mounted in supports fastened to the pan (Pl. 38, figs. 3 and 4). The shaft is placed so that there is a clearance of about a quarter of an inch between the screens and the bottom of the pan. Small metal cups half an inch wide, half an inch deep, and an inch long are soldered between each pair of screens (Pl. 38, Fig. 4). Each cup has the side wall nearest the shaft bent inward at the center in a broad "V" shape, so that the water is distributed equally over the two surfaces. It is also placed so that most of the water is released when the cup reaches the top of its circuit.

The motive power for the humidifier is a 12-inch oscillating type fan. The fan is reversed so that the blades push the air over the motor instead of away from it. This was accomplished by interchanging the end bearings, which reversed the rotor, end for end, within the field coils. The rotor and field coils are thrown out of alignment longitudinally, but the field coils can be pulled over into the proper position within the frame of the motor by means of the screws that hold the parts of the frame and the field coils together. This process reverses the direction of rotation of the blades.

The oscillating mechanism at the rear end of the fan is used to transmit the power to the shaft bearing the screens. Within the box containing the oscillating mechanism is a reduction series consisting of two spiral worms and two pinion gears. The last gear in the train has a speed of four or five revolutions per minute when the fan is running at high speed. It is keyed onto a shaft which goes through the gear box vertically, and it may be lifted out after removing the top of the gear box. This gear, after being removed from the fan, is fastened by a thin nut to the end of

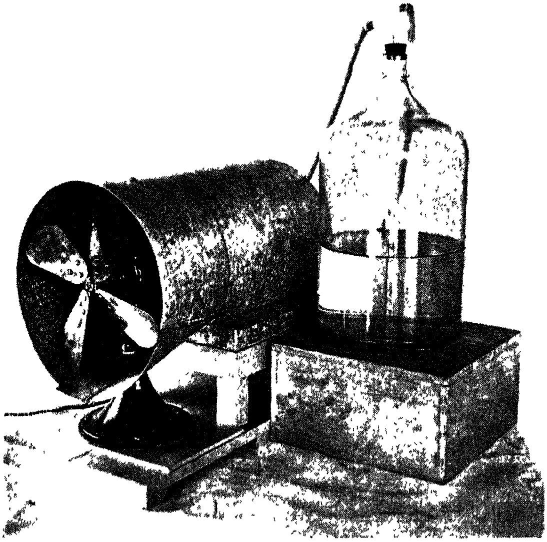
the shaft bearing the screens. A hole is cut in the back end of the gear box just large enough to accommodate the shaft. It will be seen that the gear is thus utilized on the same worm, and at the same speed as when in use for its original purpose, and the only change that has been made is in its plane of rotation. When the pan is mounted on its stand it is adjusted horizontally and vertically so that the gear meshes with the worm without putting any weight on it.

The housings for the screens and the fan are made of galvanized sheet iron. The housing for the screens is fastened to the pan by means of bolts. It is of such diameter that there is approximately half an inch clearance when the screens are rotating. This allows enough air to pass so that little back pressure is built up, and yet forces most of the air to pass over the screens. The housing for the fan is made to fit exactly into the other housing. The two are joined and held together by means of sheet metal screws; this fastens them rigidly, though they can be readily detached. It is designed to allow the fan blades a clearance of a quarter of an inch. This small clearance is to decrease the angle of the housing that results from the attached end being 1½ inches smaller than the free end. This minimum angle is desired to reduce deflected air currents. The fan and the stand holding the pan are fastened to a common base to keep them in alignment. The water is supplied to the pan from a 5 gallon bottle by means of a siphon feed. The height of the water in the pan is adjusted so that the small metal cups are completely submerged when at their lowest point. This adjustment is kept constant by using a burette funnel as an air valve (Pl. 38, fig. 4).

If it becomes necessary to increase the rate of water evaporation a small air heater may be placed in front of the fan, or an immersion type water heater may be placed in the pan.

The humidifier as described has been tested over a period of several months under various conditions. It was originally built to maintain humidity in a cellar incubator 7 feet by 7 feet by 12 feet. This room is insulated by 4 inches of waterproofed cork and plaster, and is provided with refrigeration coils. It is possible to maintain constantly a relative humidity of 94 to 95 per cent at temperatures ranging from 45° to 48°F. by running the fan at low speed. A humidity of 98 per cent was attained by running the fan at high speed and putting a small air heater in front of it. In this type of room, where humidity leakage is low, the water bottle needs refilling only once a week.

It was found possible to maintain a humidity of over 80 per cent at temperatures ranging from 60° to 70°F. in a steam-heated insectary. The walls and ceiling of the room were of plaster board. It was 13 feet



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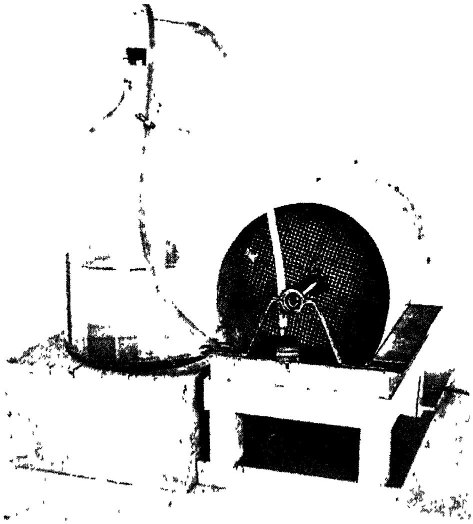
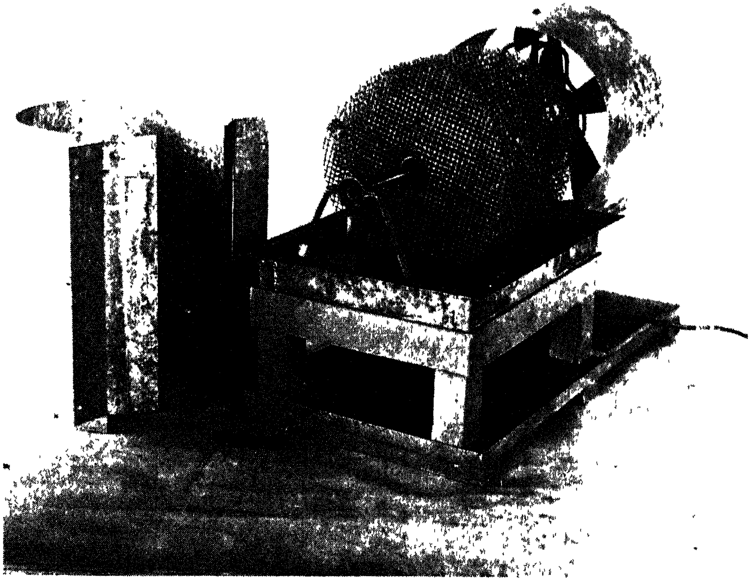


2 Humidity apparatus.



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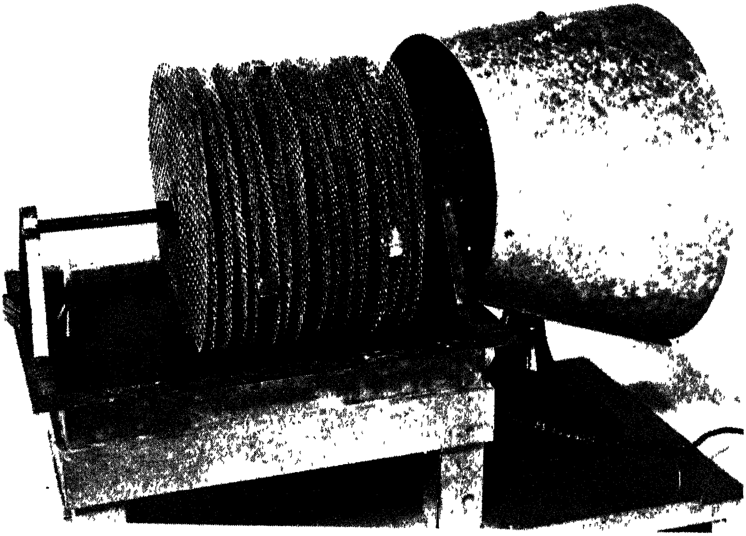


4 Humidity apparatus.

square and 8 feet high. No effort was made to record the maximum humidity that could be obtained under these conditions.

Another test was conducted in an unheated insectary 8 feet wide by 8 feet high by 24 feet long. During the test a window 3 feet by 6 feet located at one end of the room was open to the outside. The humidifier was placed at the end of the room next the window, and the recording instruments were situated at the other end. It was possible to maintain the relative humidity over 70 per cent, and ranging from 70 to 90 per cent except during windy periods, when the humidity fell to about 60 per cent.

Probably the first part to wear out in the humidifier would be the fan. With this in view the apparatus was assembled in two units so that the fan can be readily replaced. There is very little pulling load on the fan when the bearings of the screen shaft are in proper alignment, and at the end of over a month of continuous running the motor has not heated any more than one running the same length of time without the extra load. The life of a fan running constantly in an atmosphere of high humidity is about two years.

Such a humidifier as the one described can be assembled for $30 or $40. It may be adapted to many uses and various conditions. It has a possibility of being adjusted to meet varying demands by changing the size or number of the screens, by regulating the quantity of air passing over the screens, and by controlling the temperature of the water or the circulated air. When constant low humidities are required it may be impractical to vary the adjustments, and in such a case it would probably be better to use a humidistat in the fan circuit.

A MODERN GNAT TRAP

By E. O. Essig, *University of California*

For many years the Clear Lake gnat, *Chaoborus lacustris* Freeborn, has been a very great nuisance to the residents and vacationists along the shores of Clear Lake, a large body of fresh water in Lake County, California. In fact during the summer months the adult insects are so abundant and troublesome as to make the otherwise delightful evenings most disagreeable. This insect breeds in the waters of the lake in unbelievable numbers. The larvae, commonly known as phantoms because of their perfect transparency, live on the bottom during the day and come to the surface in the evenings and nights, where they feed on the plankton, and, when full grown, emerge as gnats. The gnats

swarm along the shores of the lake and collect in the tules, brush, buildings, and camps. They are attracted to lights and regularly collect about them wherever they are located near the shore. Camps, pee-wee golf courses, gasoline service stations, and residences *are fairly smothered by them!* The gnats do not bite, but inadvertently fly in the eyes, nose, ears, and mouth of those who happen to be near the lights. They also rest on the fruit trees during the day and swarm over the orchardists, especially at harvest time. The investigations of R. W. Burgess in 1928, resulted in the invention of a light trap,[1] a modification of which is now successfully used for the control of this obnoxious pest. This light trap is so simple and efficient that a description of it may assist others in solving similar problems elsewhere. The accompanying photographs, taken August 12, 1930, at the height of the gnat season, tell the story better than words. The three main points in the trap are: a light to attract the gnats, a small electric suction fan to remove them from the light, and a thin cheese-cloth bag to capture and hold the catch. The trap described is known as the Akins gnat trap and is manufactured by a local concern at Lakeport, the center of the gnat-infested district. The trap is made of thin sheet iron and is 24 inches in height, without the bag, and 15 inches in diameter. It is equipped with a 100 watt electric light bulb, with a reflector above and an electric suction fan below. The bag is of thin material to permit the ready escape of the air driven into it to carry the gnats and is 36 inches long and considerably larger than the diameter of the trap. It is securely tied about the base of the trap, so as to hang below the fan.

The traps are painted various colors to suit the aesthetic tastes of the owners and cost $10.00 each. They are suspended in various places from 6 to 30 feet above the ground to meet the exigencies of the case.

[1]Herms, W. B., and Burgess, R. W., Electric trap for night flying insects, Electrical News, pp. 29–30, 3 figs. (June 1, 1928).

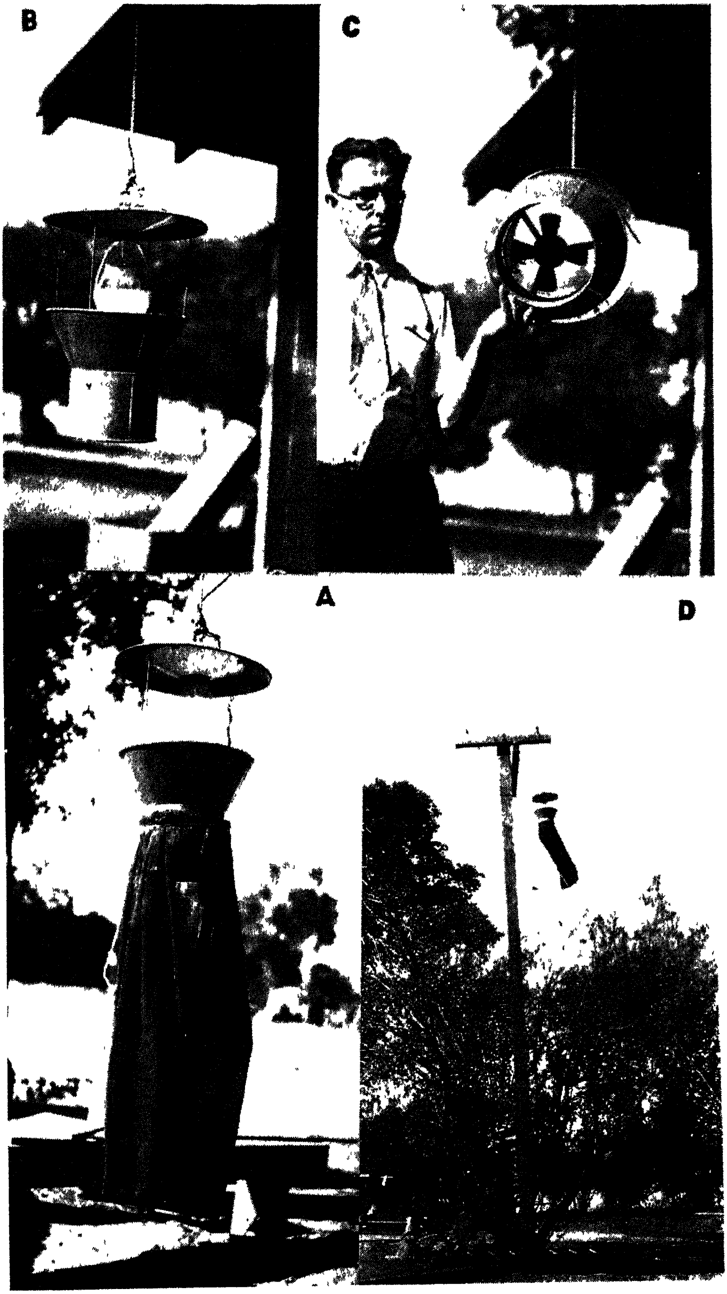
PLATE 39.—THE ATKINS GNAT TRAP

A.—The gnat trap suspended to show electrical connections, reflector, electric light bulb, and bag. The electric suction fan is located below the light where the bag is fastened.

B.—The gnat trap with the bag removed. The small bolts near the bottom hold the electric motor and fan in position.

C.—Bottom view of the gnat trap showing first the collar where the bag is attached, next the suction fan and small electric motor, and last the electric light bulb.

D.—The gnat trap suspended from an electric light pole. At night the action of the electric fan, inflates the bag.



The Akins Gnat Trap.

The trap illustrated in Plate 39, D, is one of two used to protect a pee-wee golf course. Traps around filling stations and camps are usually suspended from 6 to 12 feet high. It is an interesting sight to see the large number of these brightly colored traps hanging like Chinese lanterns along the shores of the lake and their bright lights at night add to the vacation spirit.

The effectiveness of the traps is illustrated by the fact that from 5 to 15 pounds of gnats may be taken by a single outfit in one evening—which represents a period of from two to three hours in the early evening when the gnats are on the wing. A pound of gnats is estimated to contain about two million individuals.

Great quantities of these gnats are now being used by the fish breeders in the county as a most attractive food for the young trout and other fish in the hatcheries.

Such a light trap may be useful also in collecting other night flying insects as water boatmen, mayflies, etc., or a similarly constructed trap, with a suitable bait or other attractants, instead of a light, may be employed to capture certain other types of insects.

PRELIMINARY REPORT ON A STUDY OF THE BIOLOGY OF *LIXOPHAGA DIATRAEAE* TNS.[1]

By L. C. SCARAMUZZA, *Assistant Entomologist,[2] Cuba Sugar Club Experiment Station, Central Baraguá, Cuba*

ABSTRACT

The Tachinid, *Lixophagae diatraeae* Tns., is the most important larval parasite of the sugar cane mothborer, *Diatraea saccharalis* Fabr., in Cuba. Parasitism reaches as high as 40% during spring and summer. The flies are larviparous and borer larvae can be inoculated by dissecting gravid females and placing maggots on the host. There are three larval stages, of which part of the first and second are attached to the trachea of the host while the third is always free within the host body. Six to seven days are required for the pre-larviposition period, 5.5 to 13 days in the larval stages, and 9 to 11 days in the pupal stage, making 20.5 to 32 days for the complete life cycle.

The Tachinid, *Lixophaga diatraeae* Townsend, known locally as the "Cuban Fly", is the most important and effective larval parasite of the

[1]Scientific Contributions No. 19, Tropical Plant Research Foundation. From the Cuba Sugar Club Experiment Station, Central Baraguá, Province of Camagüey, Cuba.

[2]The writer wishes to thank Messrs. H. K. Plank and U. C. Loftin, of the Department of Entomology, Cuba Sugar Club Experiment Station, for their many suggestions and assistance in carrying on the work, and the officials of Central Jaronú for their many courtesies.

sugar cane moth stalkborer, *Diatraea saccharalis* Fabr., in Cuba, Porto Rico, and some of the other West Indian Islands.

Surveys made by the Cuba Sugar Club Experiment Station (*1*)[3] have shown that this parasite is widely distributed throughout Cuba and that it is active the entire year, tho it is more abundant during the spring and summer when as high as 40% parasitism has been recorded. Altho it has been introduced and successfully established in Louisiana (*2*) and more recently reported as introduced into Mexico (*3*), Florida (*1* & *4*), Antigua, and Barbados for colonization, until the present all attempts at rearing have failed and its life history has remained unknown. This Station has recently undertaken a more intensive study of this insect to determine the possibility of increasing its usefulness locally by artificial propagation and distribution, and on account of its importance and interest to other entomologists working with the moth stalkborer of sugar cane, these preliminary notes are presented.

During the spring of 1930 the writer was assigned to this project and stationed at Central Jaronú, Camagüey province, where these investigations were made. The first attempts at rearing were made in various types of small cages but all of these proved unsuccessful. Larger cages measuring 14″ x 16″ x 36″ covered with wire screen and cheese cloth such as used for Tachinid mating and emergence at the Gipsy Moth Laboratory (*5*) were adopted. Windows made of old films cleaned of the emulsion were placed in each end to facilitate observation.

The mating cages were stacked in tiers in the laboratory where there was a free circulation of air and plenty of diffused light. The temperature ranged from about 78° to 90° F. with an average mean of around 85° F. Loaf sugar stuck to the sides of the cage with paraffin was found to be the best food. Plenty of moisture is an important factor in longevity and this was supplied by sponges set in small dishes of water and by spraying the cages several times daily with clean water by means of a small atomizer. The adults greedily drink the small drops of water from the sides and bottom of the cages. Under these conditions flies will live for as long as 40 days.

On June 25, 1930, 4 flies were confined in one of these cages with loaf sugar for food and more adults were added as they emerged from field collected puparia. On July 4, when there were 18 flies in the cage, 5 small *Diatraea* larvae which had been reared and known to be parasite free were introduced within pieces of split cane. These were left exposed to the flies for 3 days and removed from the cage. Two of these larvae

[3]Figures in parentheses refer to the "List of References" at the end of this report.

subsequently proved to be parasitized, the *Lixophaga* larvae emerging in 14 and 16 days after exposure.

Dissection of gravid females had shown that the embryonic larvae were matured while the eggs were still within the ovarian sac and that the maggots were hatched prior to or immediately after expulsion. Mr. H. K. Plank suggested and first successfully transferred young larvae secured by dissection to borer larvae with a small camel hair brush. As these entered and developed normally within the host, this method of inoculation was continued.

Mating has been observed twice, at 11 a. m. and 4:40 p. m., both times in strong diffused light but not in direct sunshine. The flies remained in copula from 3 to 3½ minutes. One of these females was dissected 55 hours after copulation was observed and the egg sac was distended with developing eggs. The other was left for 120 hours and the larvae within the eggs were found to be fully developed, but none had hatched. They were freed from the egg membrane with a dissecting needle and placed on borer larvae, and tho they were quite active, none succeeded in entering. These observations on the larval development indicate that about 6 days are required for the embryos to reach maturity.

Gravid females when dissected in saline solution were found to have 30 to 50 mature maggots in the lower ovarian sac, and several hundred immature eggs. Part of these larvae were found free of the eggs and were crawling about the sac while others hatched within a few hours. When these were removed with a camel hair brush and placed on the borer larvae, they readily penetrated the integument and entered in from ½ to 3 minutes. They select a tender spot for entrance, usually in a fold of the skin between the segments and near whatever part of the body they are placed upon. As soon as the borer larvae feel the parasites piercing their skin they become very agitated and try to dislodge them. Larvae secured by dissection have been kept alive in a saline solution for as long as 23 hours and were able to enter the host and develop normally.

While the parasites will enter the borer at any portion of the body where they are placed, the first stage larvae are later always found in the anterior half of the host with their caudal spiracles attached to the main trachea by means of a heavily chitinized tracheal funnel. Attachment is usually near the first or second abdominal spiracles, where the funnel remains permanently attached to the trachea after the larva has moulted and moved away.

The newly hatched *Lixophaga* larvae are about 1 mm. long, white in color, cylindrical in shape, and without bristles or spines. The mouth parts are well developed, terminating in two very black, slightly curved hooks. Attachment to the trachea takes place within 35 to 40 hours after entering the host and they remain in this position until after moulting once, or perhaps twice.

The second stage larvae are 2½–3 mm. long and in general appearance resemble the first stage. Some appear to remain attached to the trachea at the same place and by the same tracheal funnel as the first stage. Others appear to be free in the host body; so it is during this stage or at the time of the second moult that they become free.

The third stage larvae are 7 to 10 mm. long, creamy white in color, cylindrical, of uniform diameter, and with bluntly rounded ends. The body is covered with irregular rows of very fine bristles, mouth hooks very black and prominent, and more curved than in the other stages. Caudal spiracles are conspicuous, dark brown in color, reniform, with three spiracular openings. The third stage is always free within the host body and is without permanent respirational connections.

The length of the larval stages varies from 5 to 13 days with an average mean temperature of about 85° F. The average time for 8 males was 6.7 days; for 10 females, 7.1 days; and 40 flies of undetermined sex averaged 6.9 days. The length of the larval life depends somewhat on the size of the host, those emerging from smaller borers requiring more time. Normally *Diatraea* seem to be parasitized when they are from half to full grown (3rd to 5th instar), but *Lixophaga* have been reared from second instar borers. At other times emergence has been delayed until after pupation of the host. Sometimes two parasites and very rarely 3 develop within borers collected in the field and parasitized naturally. Under laboratory conditions when borers were inoculated with several parasites, usually all but one were killed during the second larval stage and in only one instance did two reach maturity. The borer larvae die from 6 to 48 hours before emergence of the parasite. Practically all of the body tissues are consumed in a small *Diatraea*, but with a large larva and only one parasite a considerable portion remains.

Upon reaching maturity the maggot tears an opening through the skin of the borer for emergence. This is usually in the last abdominal segment but emergence is sometimes through the anterior portion, just back of the cervical shield. The parasites may emerge either anterior or posterior end first and often reenter the borer remains if disturbed soon after emergence.

Pupation takes place within a few hours in summer but may be delayed 24 hours or more in winter. Under field conditions the puparia

are usually found in a dry place near the opening of the borer tunnel or between the leaf sheaths and stalk. In the laboratory the borer larvae are kept in tin salve boxes until after emergence and transformation of the parasites, and the puparia are then transferred to very fine, slightly moistened bagasse.

The puparia vary in size from 4.5 to 7.5 mm. (average about 6 mm.) depending upon the food, and are light brown in color when first formed, but change to dull black with age. They are slightly curved, of almost uniform diameter with well rounded ends, without spines and with the spiracles only slightly elevated. At summer temperature the pupal stage varies from 9 to 11 days but is almost invariably 10. With refrigeration this may be prolonged to 30 days or more, an important aid to introduction to other countries. Emergence takes place at any time of day or night. Two species of hyperparasites have been reared from *Lixophaga* puparia, but they are not common and are of little economic importance.

Very little is known as yet of the habits of this parasite under natural field conditions. Adult flies are found in the cane fields resting on the cane plants or feeding on pieces of cut cane, but have never been taken at other places or feeding on flowers. Judging from the structure of the mouth parts—the probosis is short and fleshy—their natural food is probably honey dew. This is always abundant on cane from the ever present mealy bugs and other Homopterons. Larviposition has not been observed but Mr. U. C. Loftin suggested placing newly born larvae on a stalk of cane near the entrance to a borer tunnel to observe their reactions. They wandered around a few moments until the borer hole was discovered, (probably attracted to it by the darkness) and immediately entered. When the holes were packed with frass, the larvae had no difficulty in working through. The canes were opened and the borers dissected 2–3 hours later, and the parasites were found inside the borer larvae, tho not yet attached to the tracheae. This is probably one of the ways by which the parasites reach the borer larvae under field conditions, as the borers are too well protected within the stalks for the maggots to be deposited directly upon their bodies.

Summary of Life History

The life history of *Lixophaga diatraeae* may be summarized as follows:

Pre-larviposition period	6–7 days
Larval stages within host	5.5–13 days
Pupal stage	9–11 days
Total	20.5–31 days

Breeding is continuous throughout the year under Cuban conditions, and there are probably 8 to 10 generations, corresponding closely with the generations of the host, *Diatraea saccharalis*.

LIST OF REFERENCES

1. PLANK, H. K. 1929. Natural Enemies of the Sugar Cane Moth Stalkborer in Cuba. Ann. Ent. Soc. America, V. 22, No. 4, (December, 1929), pp. 621–640. (Tropical Plant Research Foundation, Scientific Contributions No. 15.)
2. HOLLOWAY, T. E., HALEY, W. E., and LOFTIN, U. C. 1928. The Sugar-Cane Moth Borer in the United States. Tech. Bull. No. 41, U. S. Dept. of Agric., pp. 64–65.
3. VAN ZWALUWENBURG, R. H. 1923. Tachinids and Sarcophagids Established in Mexico. Jour. Econ. Ent. V. 16, No. 2, (April, 1923), p. 227.
4. WATSON, J. R. 1928. [Report of the Entomologist], Fla. Exp. Sta. Report for 1928, p. 47 R.
5. BURGESS, A. F., and CROSSMAN, S. S. 1929. Imported Insect Enemies of the Gipsy Moth and the Brown-Tail Moth. Tech. Bull, No. 86, U. S. Dept. of Agric., pp. 18–20.

EPHESTIA ELUTELLA HUBNER, A NEW PEST OF CURED TOBACCO IN THE UNITED STATES

By E. A. BACK and W. D. REED, *Bureau of Entomology, U. S. Department of Agriculture.*

ABSTRACT

On August 8, 1930, the moth *Ephestia elutella* Hübner was, for the first time in the United States, found infesting stored leaf tobacco in a small number of warehouses in Richmond, Va. While the insect is cosmopolitan in distribution and has been reported as feeding upon a wide range of agricultural products including tobacco, its presence in Richmond in destructive numbers has stirred the tobacco industry to prompt action looking toward effective control. Bibliography.

It is always interesting to record the appearance of a new enemy of any industry, especially an enemy that may become troublesome to an industry paying an annual federal tax of about 500 million dollars. Up to the current year, the tobacco beetle, *Lasioderma serricorne* F., has been recognized as the only serious pest of cured and manufactured tobaccos in the United States. During the past summer, rumors that a moth was damaging stored leaf tobacco in Richmond, Va., reached the Bureau and the junior writer, upon visiting the warehouses in question on August 8, found a heavy infestation of a Phycitid moth, later indentified by Mr. Carl Heinrich, of the Taxonomic Division of this Bureau, as *Ephestia elutella* Hb.

At various times throughout August and September, thousands of adult moths were to be seen during the day resting on the hogsheads and

cases of tobacco and upon screen doors and walls of the warehouses. Examination of the bright leaf tobacco stored in "hands" in the hogsheads left no doubt as to the capacity for damage possessed by the larvae. These latter were feeding upon the cured leaf, often leaving behind only the larger leaf ribs, and polluting the parts uneaten with web and frass. While the physical destruction of the leaf was very pronounced and widespread throughout about 8,000,000 cubic feet of storage space, scouting by the junior writer indicated that the infestation was confined to a rather small area of Richmond and did not extend to stocks in storage in other parts of the city or elsewhere. However, the destruction of leaf already caused, and the possibility of further spread, has given rise to grave concern in the tobacco industry and to a determination to limit the infestation to the area now infested and to exterminate it there if possible. Already the application of control measures has greatly reduced the numerical abundance of the pest.

While this is the first instance of infestation of cured tobacco by *Ephestia elutella* in the United States, the insect was recorded as a tobacco pest in Russia in 1915 (*9*) and in London during 1929. The United States Department of Commerce stated in September, 1930 (*18*), that the appearance of the worm, *Ephestia elutella,* in stocks held in bond at one of the London warehouses would, it was feared, materially depreciate the value of these stocks. The writers have been informed that the insect first appeared in London tobacco warehouses during the summer of 1929, in shipments of tobacco from Rhodesia, in sufficient numbers to cause the tobacco in hogsheads to depreciate in value. In Richmond, the brighter grades of cigarette tobacco were found most heavily infested and the feeding in hogsheads often extended as deep as 4 inches from the staves.

DISTRIBUTION AND FOOD. *Ephestia elutella* Hb. is a cosmopolitan storage pest although in America it seems to be present in negligible numbers except as above reported in tobacco, and, at times, in dried fruits in California as observed by M. E. Phillips and Perez Simmons. It has been reported from England, France, Germany, Italy, Russia, China, Africa (Cameroons, Gold Coast, Nigeria, Nyasaland, and Rhodesia), Australia, Ceylon, Java, Samoa, West Indies, Brazil, Costa Rica, Panama, Canada, and the United States (Calif., Ia., N. Y., Pa., N. J., and Va.)

The larvae have been reported as feeding upon cacao beans, cacao powder, chocolate, English walnuts, nuts, dried fruits, linseed and flaxseed meal, ships biscuits, dog biscuits, bread, cakes, coffee, red and cayenne pepper, dead insects, sugar, dried vegetables, rice, dried rhubarb roots, stored grain, seeds, cereals, pearl barley, peanuts, and tobacco.

Bibliography

1. ANDRES, A. 1920. Uber den Messingkäfer (Niptus hololeucus Feld.). (Zeitschr. Angew. Entom., vi, pp. 406–7.)
2. CURRAN, C. H., 1926. The identification and control of adult Lepidopterous insects Attacking Stored Products. (Scient. Agric., vi, no. ii, pp. 383–8, 6 figs. Ottawa.)
3. DENDY, A., and ELKINGTON, H. D., 1919. On the phenomenon known as webbing in Stored Grain (Rep. Grain Pest (War) Cttee., Roy. Soc., London, no. 4.)
4. DEONG, E. R., 1925. The Currant Moth on Peanuts. (Pan-Pacific Ent., ii, no. i, p. 46. San Francisco.)
5. FORBES, W. T. M. Lepidotera of New York and Neighboring States. Cornell Agr. Exp. Sta. Memoir No. 68, p. 623, June, 1923.
6. GIBSON, ARTHUR, and TWINN, C. R. Household Insects and Their Control. Dominion of Canada Dept. Agr. Bul. No. 112, New Series, p..29, June, 1929.
7. GRANATO, L., 1909. (Bol. Agric., San Paolo, 10, p. 283.)
8. KNAPP, A. W., 1921. Insect Pests in the Cacao-store. (Bournville Works Publication Dept.)
9. MOKRZECKI, S. A. & BRAGINA, A. T. Report of the Entomological Laboratory of the Experimental Station of Salgir for 1913–14. Simferopol, 1915, 9 pp. in Russian (R. A. E. Ser. A, Vol. 3, p. 613.)
10. MASKEW, F., 1912. A serious Walnut Pest (*Ephestia elutella* Hb.). (Mthly. Bull., State Comm. Hort., Cal., 1, pp. 366–7.)
11. ——————— 1920. Quarantine Division, Report for April and May, 1920. (Mthly. Bull., Cal. State Dept. Agric., Sacramento, ix, no.7,pp.298–302.)
12. MASON C., 1915. Report of the Entomologist for the year ending 31st March 1915. (Dept. Agric., Nyasaland Prot., Zomba.)
13. MEYRICK, E., 1928. Revised Handbook of British Lepidotera. (London.)
14. MUNRO, J. W. and THOMPSON, W. S. Report on Insect Infestation of Stored Cacao. Empire Marketing Board, Report 24, H. M. Stationery Office, London, 1929.
15. MYERS, J. G., 1928. Report on Insect Infestation of Dried Fruit. (E. M. B. 12, London, H. M. Stationery Office.)
16. PATTERSON, W. H., 1928. (Tropical Life, no. 281, pp. 25–6.)
17. SMITS,——, 1914. Une invasion d'*Ephestia elutella* Hb. à la halle aux sucres de Lille. (Feuilles jeunes Natural., Paris, 44, pp. 73–5.)
18. United State Department of Commerce Bulletin 270, Sept. 9, 1930.
19. VECCHI, A.,—— Alcune notizie sull' *E. elutella* Hb. (Boll. Soc. Ent. Ital., lix, no. 4, pp. 50-52, 2 figs., 2 refs.)
20. ZACHER, F., 1927. Sommergefahren für die Fabrikation und den Handel von Süsswaren. (Mitt. Ges. Vorratschutz, 3 no. 4.)
21. ————, 1927. Die Vorrats-Speicher-und Materialschädlinge und ihre Bekampfung., p. 250. (Berlin, Paul Parey.)

Scientific Notes

Oriental Fruit Moth Infestation in Georgia Peach Belt.—Owing to the absence of a host after midsummer, which causes a heavy mortality of oriental fruit moth larvae that would otherwise hibernate, this insect has never been of much economic importance in the central Georgia peach belt. However, there has been considerable speculation as to the extent of infestation in peaches harvested in that district, and at times growers have held the oriental fruit moth responsible for damage caused by the plum curculio. In order to obtain accurate data on the degree of infestation, all of the peaches from 50 record trees scattered throughout what was apparently the most heavily infested orchard in the vicinity of Fort Valley in 1930 were cut open to determine which contained oriental fruit moth larvae or had been damaged by the insect. No control measures whatever for the oriental fruit moth, had been practiced in this orchard, and the fruit was not harvested until after the larvae had ceased to work in peach twigs on account of their hardened condition. The 50 record trees produced 35,663 peaches, all of which were cut open, and of these only 452, or 1.3 per cent, were found to be infested by the oriental fruit moth.

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U. S. Peach Insect Laboratory, Fort Valley, Georgia

Benjamin Franklin on Entomology. In looking through "The Complete Works of Benjamin Franklin," edited by John Bigelow and published by Putnam in 1887, I noticed a letter from Franklin to Miss Mary Stevenson, written in London and dated June 11, 1760. As the letter is of interest to entomologists and has doubtless escaped the attention of many of them, it seems worth while to reproduce in an entomological journal that part of it which treats of the study of insects. Entomologists will be interested both in the record of Linnaeus's success in an economic investigation and in Franklin's counsel that entomology be studied in moderation. The quotation follows:

"Your observation on what you have lately read concerning insects is very just and solid. Superficial minds are apt to despise those who make that part of the creation their study, as mere triflers; but certainly the world has been much obliged to them. Under the care and management of man, the labors of the little silkworm afford employment and subsistence to thousands of families, and become an immense article of commerce. The bee, too, yields us its delicious honey, and its wax useful to a multitude of purposes. Another insect, it is said, produces the cochineal, from which we have our rich scarlet dye. The usefulness of the cantharides, or Spanish flies, in medicine, is known to all, and thousands owe their lives to that knowledge. By human industry and observation, other properties of other insects may possibly be hereafter discovered, and of equal utility. A thorough acquaintance with the nature of these little creatures may also enable mankind to prevent the increase of such as are noxious, or secure us against the mischiefs they occasion. These things doubtless your books make mention of; I can only add a particular late instance which I had from a Swedish gentleman of good credit. In the green timber, intended for ship-building at the King's yards in that country, a kind of worms were found, which every year became more numerous and more pernicious, so that the ships were greatly damaged before they came into use. The King sent Linnaeus, the great naturalist, from Stockholm, to inquire into the affair, and see if

the mischief was capable of any remedy. He found, on examination, that the worm was produced from a small egg, deposited in the little roughnesses on the surface of the wood, by a particular kind of fly or beetle; from which the worm, as soon as it was hatched, began to eat into the substance of wood, and after some time came out again a fly of the parent kind, and so the species increased. The season in which the fly laid its eggs, Linnaeus knew to be about a fortnight (I think) in the month of May, and at no other time in the year. He therefore advised, that, some days before that season, all the green timber should be thrown into the water, and kept under water till the season was over. Which being done by the King's order, the flies, missing their usual nests, could not increase; and the species was either destroyed or went elsewhere; and the wood was effectually preserved; for, after the first year, it became too dry and hard for their purpose.

"There is, however, a prudent moderation to be used in studies of this kind. The knowledge of nature may be ornamental, and it may be useful; but if, to attain an eminence in that, we neglect the knowledge and practice of essential duties, we deserve reprehension. For there is no rank in natural knowledge of equal dignity and importance with that of being a good parent, a good child, a good husband or wife, a good neighbour or friend, a good subject or citizen—that is, in short, a good Christian. Nicholas Gimcrack, therefore, who neglected the care of his family, to pursue butterflies, was a just object of ridicule, and we must give him up as fair game to the satirist."

T. E. HOLLOWAY, *U. S. Bureau of Entomology*

A Suggestion for the Automatic Collection of Sitotroga.—The successful utililization of the egg parasite *Trichogramma* depends on low production costs. At the present time the greatest advance toward this objective would be in reducing the time and labor now required in making the daily collections of the adult stage of its host. Recent investigations (see October number of the Journal) indicate that the use of the apparatus described in the following paragraphs would result in such a saving.

When the bins containing infested corn are stacked in position for production, the upper ends of the bins are covered with a single piece of closely woven cloth (4 feet square) hanging loosely from the cover of the top bin. This cloth is securely fastened at its four sides so that the moths cannot escape. The lower edge is attached to the outer side of a funnel having an opening 1 inch in width extending the width of the bins (4 feet) and on a level with and attached to the bottom bin. The lower or small end of the funnel is connected to the moth trap which is described on Page 838 of the October number of the Journal.

When in operation, a constant current of air enters at the top of the enclosure formed by the cloth and passes down between the bins through the mass of grain and out through apertures at the lowest part of each bin. The air pressure causes the cloth to bulge outward. The moths that collect in the cloth enclosure are collected at intervals in the trap by cutting the air pressure on and off rapidly several times, so as to shake the cloth, causing the moths to settle into the funnel and, at the same time, starting the suction motor on the trap.

STANLEY E. FLANDERS, *Citrus Experiment Station, Riverside, California*

A Predacious Mite on Alfalfa Thrips.—As far as the writer is aware, only one species of mite, *Hypoaspis* (*Laelaps*) *macropilis* Bks., has been reported from North America as preying on thrips. In connection with studies of alfalfa thrips (*Frankliniella occidentalis* Perg.), conducted in the vicinity of Greenwood, Utah, during 1928 and 1929, another species of mite was observed preying on this species of thrips to such an extent that it appeared to be an effective factor in reducing thrips population. Dr. H. E. Ewing had placed it as *Anystis agilis* Bks. (?) which is well-known to be predacious on various small insects. The mite was found in alfalfa flowers and to some extent running on the ground beneath the plants. Populations of the mite appear to vary directly as the thrips population, being higher during August and early September. At this time it was not uncommon to find two or three mites in several racemes. Where the mite was scarce, as was true in some localities, thrips populations were much higher than in localities where the mite (*Anystis agilis* Bks.) was established. In addition to this mite, another well-known thrips predator, *Orius* (*Triphelps*) *insidiosus* var. *tristicolor* White, which was identified by Dr. Drake, through the kindness of Mr. Harold Morrison, Bureau of Entomology, was found more abundantly than the mite and actively preying on the host throughout the season. A test of the relative effectiveness of these two species as predators was taken during September. These data are summarized below:

	Period of exposure Average	No. of cages	Total no. of thrips	Thrips per cage Average	No. of predators per cage	No. killed	Per cent	Number survived
Anystis	25 hours	5	132	26.6	1	52	39.39	80
agilis	49 "	4	99	24.7	1	20	20.20	79
Orius	27 "	5	108	21.6	1	24	26.85	84
tristicolor	49 "	4	93	23.2	1	31	33.33	62

K. Sakimura, *University of Hawaii, Honolulu, Hawaii*

An Additional Statement Concerning the Tank-mixture Method of Using Oil Spray.—The article on the tank-mixture method of using oil spray, appearing in the April number of the Journal of Economic Entomology and subsequently reprinted in Citrus Leaves and in Texas Citriculture, has occasioned a reaction which appears to warrant commenting upon at this time. It goes without saying that men in science and industry alike properly should take a conservative position with respect to pronouncements which suggest decided departures from generally accepted lines of thought and practice. Two principal factors are involved in the present case, the *a priori* position taken by entomologists and the horticultural industry that "home made" spray is taboo and the denunciation by the insecticide industry, through the medium of its salesmen and other personnel, of the idea that a method of using oil spray has been demonstrated which carries the possibility of eliminating to a large extent the use of prepared emulsions. The writer takes it for granted that the criticisms expressed are, for the most part, made in good faith. Much reference has been made to the fact that the enthusiasm over the so-called boiled lubricating oil emulsions and cold emulsions during the two or three years following the publication of formulae in 1922 and 1923 waned very quickly in the Pacific Northwest as a result of somewhat disastrous experiences. The implication is that the experience with "home made" oil spray has been such that to permit information to be printed which might encourage its use again is a dangerous and foolish thing for one to do. Future

research and experience will, of course, settle the questions that have been raised, but certain points concerning the oil spray work can be elucidated at this time with profit to all who may be interested..

(1) In the article referred to the writer specifically stated that the tank-mixture method probably has an important place in the spraying of citrus trees under the conditions of pest control existing in southern California and whether or not it is applicable to conditions met with in deciduous fruit districts, in dormant and summer spraying, remains to be determined by entomologists in such districts.

(2) It is true that oil sprays in the form of "mechanical mixtures" of oil and water, with and without the addition of soap or soap powders, were used more or less extensively prior to about the year 1910 and that this type of spray was completely abandoned in favor of prepared emulsions and miscible oils. The change might have been fully justified at the time it was made but with modern spray equipment and recent additions to our understanding of the functioning of oil spray mixtures, the return to the original method is distinctly in the line of progress; at least as pertains to spraying in the citrus districts in California.

(3) The disastrous experiences, if they were such, which may have resulted from the use of engine oil emulsions in the Pacific Northwest and elsewhere, were obviously due to an inadequate knowledge of certain facts which are well understood in the present case concerning spray oils and oil spray mixtures. The tank-mixture method is based on the fundamental tenet that in the use of an oil of given specifications as to viscosity, distillation range and sulfonation, the insecticidal efficiency and injurious effects, insofar as the spray mixture is concerned, depends entirely upon the amount of oil deposited during the process of spraying; and the amount of oil deposited can be governed by placing the spreader or emulsifying material directly in the water in the spray tank, adding the spray oil and maintaining a uniform mixture by means of the agitators. The stability of the emulsion or spray mixture and the size of the oil globules, factors which heretofore have been the focus of attention of oil spray investigators and oil spray manufacturers, become relatively negligible in importance.

(4) The tank-mixture cannot be regarded as a "home made" oil spray because the ingredients consist of a quantity of pure spray oil and a quantity of spreader, which are added separately to the water in the spray tank. No particular instructions must be followed concerning the order in which the ingredients are added or the time when they are placed in the tank. It is no more a "home made" spray than is a spray of lead arsenate, lime-sulfer, Bordeax mixture or nicotine sulfate to which a spreader is added.

(5) The dependability of the tank-mixture method hinges upon proper agitation and the proper kind and amount of emulsifier. The practicability of increasing the agitation in spray tanks so as to meet the requirements for the tank-mixture method has been established beyond any question of doubt in the case of modern, high-powered sprayers such as are used altogether in southern California. In other sections of the country where growers do their own spraying and the spray machines represent all vintages and are, in many cases, decidedly underpowered, the practicability of the tank-mixture method is questionable. No encouragement of its use should be made until the factors pertaining to spraying equipment have been carefully surveyed. It is the writer's firm belief, however, that in view of the difficulty experienced more or less generally with emulsions separating in containers before use and breaking when mixed with water in the spray tank, due to reactions between salts in the water and the emulsifying agent in the emulsions, all sprayers applying oil

spray should meet the agitation requirements which have been specified for the tank-mixture method.

(6) The term "emulsifier" loses its significance when used in connection with the tank-mixture method because no emulsion in the ordinary sense, is produced. The term "spreader", with the meaning that it generally conveys in insecticide literature, is perhaps a more suitable word because the object to be achieved is to govern the deposit of oil on the tree and that appears to be accomplished primarily by a phenomenon of wetting by the spray mixture. Since the article above referred to was published, considerable attention has been devoted to finding a suitable spreader for use with the tank-mixture. The shortcoming of caseinate spreaders and soaps is that very commonly their effectiveness is destroyed by reactions with the salts in the spray water. In spraying with lead arsenate such spreaders may be used in excessive amounts in order to offset the effect of reactions with the salts in the water, but this practice is not feasible in the case of oil sprays, especially those used on foliage, because the margin between safety and killing efficiency is very much narrower in the use of oil sprays than in the use of lead arsenate. The ideal spreader is one which is not subject to the reaction mentioned and it must also have the particular property of causing the spray mixture to wet in such a manner as will prevent the deposit of oil from becoming excessive. At the present time powdered blood albumen appears to be one of the most promising oil spray spreaders. It appears to have been used in a limited way in spray work in the past and a proprietary preparation in liquid form has been in use with a proprietary emulsion in California during the past four or five years.

A publication covering the oil spray investigation is in the course of preparation and it will probably be ready for distribution prior to the spray season next summer.

Ralph H. Smith, *Associate Entomologists, University of California, Citrus Experiment Station*

A Note on the Relation Between Insecticidal Action and the Physical Properties of Soap Solutions.—In a study[1] published in 1929, it was shown that the kill produced by soaps as contact insecticides against the Japanese beetle varies strikingly with the kind of soap used. For example, with the potassium soaps produced from palm oil, corn oil, and castor oil, the per cent of beetles killed by an application of a spray containing 4 pounds of soap in 50 gallons of water (practically 1 per cent solutions) was 70, 50, and 2, respectively.

An effort has been made to find a correlation between certain physical properties of the soaps and their killing power. Since wetting and penetration are influenced greatly by the surface tension of the solutions, a determination of this property was made, using a Du Nouy surface tension apparatus. The surface tension was found to be fairly low in all cases, and no definite relation was found to exist between the surface tensions of the soap solutions and the killing power.

A microscopic examination of beetles sprayed with soap solutions was made for us by Mr. E. A. Richmond, formerly of this laboratory, with a view to determining whether there is any great variation in the penetration of the soap solutions into the

[1]A study of the insecticidal properties of soaps against the Japanese beetle, by P. A. van der Meulen and E. R. Van Leeuwen. Jour. Econ. Entomology, 22, 812–4 (1929).

spiracles and tracheae of the beetle. Mr. Richmond states that the penetration is substantially the same with the three soaps mentioned above.

It seems to be true that one obtains good wetting and penetration in all cases, owing largely to the fact that the surface tension of all the solutions is fairly low. It is evident that some factor other than surface tension plays a decisive role in this case.

As the rate of flow of a liquid through a tube of capillary dimensions is governed by the viscosity of the liquid, a determination of this property of the soap solutions was made at several concentrations, using a MacMichael viscosimeter. There did not appear to be any relation between the viscosity and the insect kill.

When 1 per cent solutions of the various soaps were placed on watch glasses and allowed to remain exposed to the air of the laboratory for a period of 15 to 30 minutes, it was found that the surface became covered in most cases with a skin of soap. Whether this skin or film consists of neutral soap, or whether it contains more or less of the acid soap, is not certain. It is a fact, however, that the films differ greatly in strength with the different soaps. In the cases of the potassium soaps, for example, the soap made from palm oil (70 per cent kill) forms a very tough skin which adheres very firmly to the watch glass. The same is true to a lesser extent of the potassium soaps made from beef tallow, coconut oil, mutton tallow, and cocoa butter (68 to 55 per cent kill). With the soaps made from lard, cottonseed oil, soy bean oil, and corn oil (54 to 50 per cent kill), the film either does not adhere to the watch glass, or is very easily loosened by blowing on the surface. With the potassium soaps made from neatsfoot oil, potassium oleate, menhaden oil, olive oil, and linseed oil (48 to 25 per cent kill), the film is not continuous, and does not adhere to the watch glass. The potassium soaps made from Japan wax, castor oil, rape oil, whale oil, and cod liver oil (8 to 2 per cent kill) either do not form a film at all, or else form very weak ones. There is very evidently a relation between the insect kill and this film formation. The soaps which form the toughest and most adherent films give the highest insect kill, and those which form less tenacious and weaker films give a lower kill, while absence of film formation corresponds to absence of kill.

In view of the importance of soaps as contact insecticides, it would be interesting to have this study extended to insects other than the Japanese beetle.

P. A. VAN DER MEULEN, *Agent, United States Department of Agriculture*
Moorestown, New Jersey

***Hermetia illucens* L.—A Pest in Sanitary Privies in Louisiana.** During August and September, 1930, several complaints were received by the health authorities of Lincoln Parish, Louisiana, from persons living in rural districts on account of large numbers of wasp-like flies which were infesting their recently installed sanitary privies. The flies, which were identified by Mr. C. T. Greene of the Bureau of Entomology as *Hermetia illucens* L., were breeding in the privy pits, and whenever a seat cover was raised they would come out in swarms. In some cases a few sluggish individuals would crawl unnoticed into the underwear of the person using the privy. Due to the superficial resemblance of these flies to certain wasps, and the buzzing noise which they make when confined in close quarters, considerable consternation often resulted when a person lifted a privy lid and was greeted by a swarm of insects resembling wasps, or when upon leaving the privy he experienced a strange creeping and buzzing sensation due to flies being confined within his garments.

These conditions led some persons to abandon the new privies for those of the old surface type, while others were found to be tying the seat covers back to allow the flies to escape, and thereby admitting house flies and mosquitoes to the pit to breed. This situation was very trying to the health officials, who up to the time the fly nuisance began were receiving excellent cooperation from the people in the rural districts in a campaign for sanitation throughout the parish. F. C. Bishopp states that a similar situation was observed by him in central Florida in 1929.

The type of privy causing the nuisance is known to sanitary workers as the Virginia sanitary privy, which embodies the following features of construction: a vault or pit which is lined with wood and is covered at the top by the privy floor and seat box; a frame shed which is attached at the bottom to a curbing which surrounds the pit lining at the top; a vent pipe leading from the top of the seat box through and extending about two feet above the roof. The vent is made fly proof by a copper screen covering the bottom end where it rests on the seat box. The seat covers are hinged at the back with strips of automobile tire casing which operate as springs to make the covers self-closing. A mound of earth is built up around the base of the privy even with the floor which covers any cracks in the top of the pit lining and keeps the curbing from rotting rapidly. The privy is thus practically fly proof, the only chance of flies entering the pit being when a seat cover is open.

A short study of the situation showed that the adult *H. illucens* were depositing their eggs in cracks and in spider webs in the interior of the vent pipe. Some batches were found at the very top of the vent pipe under the rain cap. Upon hatching the larvae readily fall or crawl down through the screen at the bottom of the pipe into the pit where the larval and pupal stages are passed. The larvae serve to break up the solid excreta and thus hasten decomposition. All of the larvae do not pupate in the pit, as some are able to crawl up the perpendicular sides, escape through cracks, get into the earth outside and pupate near the surface close to the privy. This habit is an additional nuisance as chickens, in searching out the pupae, tear down the earth mound which is built around the privy and make it difficult to maintain.

A few tests with common oils, disinfectants and poisons showed that the larvae could be killed in pits in which the excrement was in a liquid state by a heavy application of gas oil, or in pits in which the excrement was semi-solid by a thin coating (about ¼ pound) of Paris green. Inasmuch as the flies are of little economic importance, however, it would appear that there is no need to advise either killing the larvae by poisoning, which treatment would certainly be neglected in most cases, and which would give those persons holding out against a sanitary privy installation an additional point for objection; or to devise a new type of vent pipe with more elaborate screening to prevent the pit from becoming infested, which would entail increased labor and care in construction and a slight increase in cost of materials. The best solution appears to be to devise a trap opening into the vault which will admit sufficient light to attract and capture the emerging flies or allow them to escape without admitting house flies and mosquitoes. The flies enter homes and visit foodstuffs very rarely, hence their escape is of no particular sanitary importance. Preliminary tests with traps designed to accomplish this purpose, located in the vent, in the floor, and in the seat box, are now in progress.

G. H. Bradley, *Division of Insects Affecting Man and Animals, U. S. Bureau of Entomology*

Rotenone as a Moth-proofing Agent.—Rotenone is one of the insecticidal constituents of derris root, cubé root, and other tropical fish poisoning plants. It is a crystalline material of the formula $C_{23}H_{22}O_6$, with a melting point of 163°C. It is quite insoluble in water, is very slightly soluble in petroleum oils, slightly soluble in alcohol and ether, and readily soluble in chloroform, ethylene dichloride, and other clorinated hydrocarbons.

Cooperative experiments conducted by the Federal Bureaus of Entomology and Chemistry and Soils, begun during June, 1929, and extending to date, have demonstrated that solutions containing 1 percent to 2 percent of rotenone dissolved in acetone, if used thoroughly to impregnate woolen goods, imparts a resistance to fabric pests that is of practical value, if conclusions can be drawn from laboratory tests run in petri dishes in accordance with the usual method now in vogue for testing moth-proofing solutions. Experiments involving *Tineola bisselliella* Hum., *Anthrenus vorax* Casey, and *Attagenus piceus* Oliv. have proved the value of the rotenone solutions in acetone against these major fabric pests. In fact, even weaker solutions, some containing only 0.05 percent of rotenone, gave excellent protection. The protection, or moth resistance, imparted to the treated fabrics appears to equal that imparted by any proprietary moth-proofing solution now offered the public. Application for a Public Service Patent has been filed with the U. S. Patent Office by the U. S. Department of Agriculture.

E. A. Back and R. T. Cotton *Bureau of Entomology* and R. C. Roark,
Bureau of Chemistry and Soils U. S. Department of Agriculture.

CONNECTICUT ENTOMOLOGICAL WORKERS

The Seventh annual convention of Entomologists working in Connecticut was held in the old Senate Chamber, State Capitol, Hartford, on Friday, October 31, 1930. Subjects of vital importance to Connecticut were given a prominent place on the program, and several Federal Entomologists were invited to address the conference. The following Entomologists from outside of Connecticut presented papers: Lee A. Strong, Washington, D. C., C. H. Hadley, Camden, N. J., L. H. Worthley, Boston, Mass., A. F. Burgess, Melrose Highlands, Mass., and Donald S. Lacroix, Amherst, Mass. About 72 attended the conference. The following program was carried out without a single substitution except that on account of sickness Governor Trumbull was unable to be present:

Greeting, His Excellency, John H. Trumbull, Governor.

Qualifications and Training of Men for Agricultural Research, Director Wm. L. Slate, Agr. Expt. Station, New Haven.

Prominent Entomological Features of the Season, Mr. M. P. Zappe, Agr. Expt. Station, New Haven.

The Need of Organized Control of Plant Pests, Hon. S. McLean Buckingham, Commissioner of Agriculture, Hartford.

Certain Aspects of Federal and State Cooperation in Pest Control, Mr. Lee A. Strong, Chief, Plant Quar. & Control Admin., Washington, D. C.

Observations on Ant Lion Colonies, Mr. B. H. Walden, Agr. Expt. Sta., New Haven.

The Present Situation as Regards the Japanese Beetle in the United States, Mr. C. H. Hadley, In Charge, Preventing Spread of Japanese Beetle, Camden, N. J.

Control of the Squash Vine Borer, Dr. R. B. Friend, Agr. Expt. Sta., New Haven.

Survey of Corn Borer Conditions in the United States, Mr. L. H. Worthley, Administrator, Corn Borer Control, Boston, Mass.

Results of Scouting and Road Patrol in Connecticut, Mr. H. N. Bartley, Norwalk.

Shade Tree Insects and Control Methods, Dr. E. P. Felt and S. W. Bromley, Stamford.

Rearing and Liberating Parasites to Control the Oriental Fruit Moth, Dr. Philip Garman, Agr. Expt. Station, New Haven.

Present Status of the Gipsy Moth and the Satin Moth in New England, Mr. A. F. Burgess, In Charge of Moth Control, Melrose Highlands, Mass.

Early Entomological Work in Connecticut, Dr. W. E. Britton, Agr. Expt. Station, New Haven.

Some Entomological Observations, South, West and East, Dr. R. M. DeCoursey, Conn. Agr. College, Storrs.

Insects in the Childrens' Museum, Mr. J. S. Miller, Hartford.

Progress in Mosquito Elimination Work in Connecticut, Mr. R. C. Botsford, Agr. Expt. Station, New Haven.

Progress in Controlling the White Pine Blister Rust in Connecticut, Mr. J. E. Riley, Jr., Agr. Expt. Station, New Haven.

Insects Injuring Tobacco in Connecticut in 1930, Mr. Donald S. LaCroix, Amherst, Mass.

The following were present: Dorothy Amrine, New Haven; John T. Ashworth, Danielson; H. N. Bartley, Norwalk; John H. Belden, Hartford; H. L. Blaisdell, Melrose Highlands, Mass.; R. C. Botsford, New Haven; W. E. Britton, New Haven; Stanley W. Bromley, Stamford; Gladys Brooke, New Haven; S. McLean Buckingham, Hartford; A. F. Burgess, Melrose Highlands, Mass.; G. W. Burke, Shelton; T. M. Cannon, Hartford; V. L. Churchill, New Haven; C. W. Collins, Melrose Highlands, Mass.; O. B. Cooke, Danielson; R. G. Cooper, Colebrook; E. B. Davidson, Storrs; R. M. DeCoursey, Storrs; Charles M. Dittrich, Jr., Storrs; B. M. Ellis, Storrs; C. M. Emerson, East Hartford; E. P. Felt, Stamford; B. J. Fitzsimmons, Jr., Storrs; R. B. Friend, New Haven; C. W. Frink, Willimantic; Philip Garman, New Haven; R. D. Glasgow, Albany, N. Y.; C. H. Hadley, Camden; N. J.; Kenneth N. Hanks, Storrs; A. F. Hawes, Hartford; S. P. Hollister, Storrs; C. E. Hood, Melrose Highlands, Mass.; C. E. Jennings, New Haven; J. Peter Johnson, Shelton; J. F. Keough, Willimantic; Dolor LaBelle, Ballouville; Donald S. Lacroix, Amherst, Mass.; G. H. Lamson, Storrs; J. B. Lewis, Southington; J. W. Longo, Danielson; J. A. Manter, Storrs; J. A. McEvoy, Putnam; B. W. McFarland, New Haven; H. L. McIntyre, Albany, N. Y.; Dorothy E. Miller, Meriden; J. S. Miller, Hartford; E. S. Peterson, Shelton; Saul Phillips, Albany, N. Y.; G. E. Pinckney, Jr., Storrs; H. A. Preston, East Hartford; J. E. Riley, Jr., New Haven; R. M. Ross, New Haven; J. V. Schaffner, Jr., Melrose Highlands, Mass.; John C. Schread, New Haven; Frank R. Shaw, Belchertown, Mass.; M. T. Smulyan, Melrose Highlands, Mass.; Lee A. Strong, Washington, D. C.; J. F. Townsend, New Haven; Ethel Usher, Hartford; B. H. Walden, New Haven; R. L. Walker, Storrs; George S. Wheeler, Shelton; E. H. Wilkins, Hartford; A. E. Wilkinson, Storrs; L. H. Worthley, Boston, Mass.; M. P. Zappe, New Haven.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

DECEMBER, 1930

The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication at $2.50 per page for all matter in excess of six printed pages, a part page counting as a full page, this limit not including acceptable illustrations. Photo-engravings may be obtained by authors at cost.

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ANNUAL SCIENTIFIC MEETINGS: 1930-31, Cleveland; 1931-32, probably New Orleans; 1932-33, Chicago; 1933-34, undecided; 1934-35, probably Rochester.

Paris green was for many years the standard arsenical poison for insects. Its limitations became very evident in the early days of the gipsy moth work. The possibilities of arsenate of lead were worked out and it is now the standard arsenical compound used for the control of many insects. The spray residue problem has brought this latter compound into disrepute and a search is on for something better. It will be found, in all probability. The business of poisoning insects has grown to such a magnitude that only the best will suffice. There appears in this issue an account of tests with 283 materials made in a search for an acceptable substitute for arsenate of lead. This work is a suggestion as to what may be expected. The numerous studies of various phases of the insecticide problem are destined to result in important discoveries and we may reasonably expect valuable additions to the available insecticidal ammunition.

A recent Technical Bulletin on economic entomology gives temperature readings in the orchard in Fahrenheit degrees and the readings in experimental compartments in Centigrade, with an occasional indication of equivalents between the two. There is no question as to the greater convenience of metric units. There may be a question as to the advisability of using these in economic publications, even in technical bulletins, since presumably many copies of these would go to readers not sufficiently conversant with the two systems to make a ready transposition. It is perhaps equally obvious that a uniform system should be

followed throughout a publication and we would make no exception in the case of technical bulletins. From a practical standpoint, we are unable to see any great gain in using metric units wherever there is likely to be a more or less insistent need of transposition to the more generally accepted systems. Economic literature, technical or otherwise, has a very practical application and anything which tends to render this more difficult for the general reader defeats in a measure at least, the purpose of the publication.

Obituary

EDWARD FOSTER

Many entomological visitors to New Orleans during the past quarter century and more will regret the passing of the genial "Ed Foster," widely known as an amateur entomologist, collector and naturalist. Mr. Foster died at his home in New Orleans on October 8, 1930, aged 67, having been confined to his bed since February.

Mr. Foster, a native of England, came to New Orleans in his early twenties. He was of an old English family, and was a nephew of Lord Halliburton. He had a brilliant mind and an excellent education. His memory was amazing. It was said that he could give as much information on any subject as a small encyclopedia.

He was at first employed in New Orleans in a cotton firm. He afterwards joined the staff of the old *Picayune*, and it was his duty to report the activities of the Board of Trade, the Cotton Exchange, the Sugar Exchange, etc. "He ranked high as a journalist," says a newspaper article, "and was regarded as one of the best posted editorial writers, especially on commercial subjects." He took a prominent part in the eradication of yellow fever from New Orleans. When *The Picayune* merged with *The Times-Democrat* (forming *The Times-Picayune*), Mr. Foster became connected with the Louisiana Experiment Stations. He was afterwards employed for a while as an assistant at the Mound, La., laboratory of the Bureau of Entomology. Later he became an entomologist for the Louisiana Department of Agriculture. He held this position till his death. For many years he was also the Louisiana reporter for the New York sugar journal, *Sugar*.

Though possessed of a wide knowledge of insects, he was not a prolific writer on entomology. In fact, the only contribution known to the undersigned is, "The Introduction of *Iridomyrmex humilis* (Mayr) into

New Orleans," published in THE JOURNAL OF ECONOMIC ENTOMOLOGY, Vol, 1, pages 289–293, 1908. However, he was generous in sharing his knowledge with other workers, and he would often direct one's attention to some obscure publication or reference. For some years he was engaged in making a card index of publications on the insects of Louisiana. This was in addition to his regular duties.

Mr. Foster was one of the founders of the Louisiana Entomological Society, in 1920, being its first president. He also held the position of secretary-treasurer for a long time.

His wife died two years ago. Two children, Mr. Edward Foster, Jr., and Mrs. Clay W. Brooks, survive.

Mr. Foster's death causes a real vacancy in the entomological circles of New Orleans and Louisiana.

T. E. HOLLOWAY

Reviews

The Biological Control of Insect and Plant Pests, by W. R. THOMPSON, pp. 1-124, H. M. Stationery Office, London, 1930.

Every one interested in the biological control of either insect or plant pests would benefit by the opportunity of studying this most excellent report on the "Organization and Progress of the Work of the Farnham House Laboratory," which was founded by the Imperial Bureau of Entomology some three years ago, by means of a grant from the Empire Marketing Board, with the main object of the furtherance of the control of insect pests of agriculture and forestry by means of what is known as the biological method. The first grant of the Empire Marketing Board was for 15,000 pounds for capital expenditures and 5,000 pounds per annum for maintenance expenditures during the following five years. Due to the rapid development of the work of the Laboratory, the funds allotted for annual maintenance proved decidedly inadequate, and the Imperial Bureau, after a conference with representatives of the Empire Marketing Board, secured a grant of an additional 2,000 pounds per annum from 1st July, 1929. In 1929 also, at the request of the New Zealand Government, the Laboratory took over the conducting of the European end of the work on the insect enemies of New Zealand weeds and received from the New Zealand Government a special grant of 1,000 pounds per annum for this work. Small subsidies have been made by the Commonwealth Council for Scientific and Industrial Research in Australia, the New Zealand Government, the Government of Cyprus, etc.

The Farnham House Laboratory is located in a 15-room country house about 25 miles from London, with about 6½ acres of ground thereabout. From the description in part III of the present report, the Laboratory and grounds would seem to be excellently and most modernly equipped for the work in hand and supplied with a highly competent staff.

Dr. Guy A. K. Marshall, the well-known Director of the Imperial Bureau of Entomology, in his preface to the report considers that the creation of the Labora-

tory has met a real need in imperial entomology, as proven by the response of the dominion and colonial entomologists to offers of assistance. Even before the Laboratory was open for work, requests for help were received, and up to this time the list of injurious insects and plants which the Laboratory has been asked to investigate with the hope of finding natural enemies comprises some 70 species. An idea of the widespread diversification of the investigations under way may be obtained from the fact that the Dominion of Canada alone has submitted to the Laboratory projects involving the natural control of no less than 28 species of injurious insects, while Australia has submitted 16; New Zealand, 14 projects of insects and 5 of obnoxious weeds; South Africa, a project of biological control of the Sheep Blow-fly; India, projects of Woolly Aphis and Fluted Scale; West Indies, one on Pink Boll Worm; Cyprus, on Codling Moth and Potato Tuber Moths; the Falkland Islands, on Blue Bottle Fly; and the United States of America, a project of the Pink Boll Worm and the Carrot Rust Fly. Up to the date on which this report was sent to press last June, a total of 73 consignments of beneficial insects, containing approximately 285,000 living individuals, was sent out by the Laboratory. These shipments included some 24 species of beneficial insects attacking 17 species of pests. So much for the actual progress of the work of this splendid institution which is materially adding to our knowledge of both theory and practice of biological control of agricultural pests!

Probably of most interest from the reviewer's standpoint, however, is part II of the report, which is devoted to a general account of the problems encountered in biological control operations with special reference to the organization and practical conduct of work in this, as yet, comparatively unexplored and most promising field in economic entomology. As Dr. Thompson mentions in his brief introduction, a certain number of purely theoretical considerations have been included because of their value in indicating lines of research in both field and laboratory, and, in view of the clear and concise manner in which these theoretical considerations have been handled by the author, there should be no doubt that their inclusion has added to the practical value of the work. The great majority of the statements and suggestions, however, are the fruit of a generation of practical work in this field and have the seasoned value of having been repeatedly tested and practiced. This section of the report constitutes one of the most complete and understandable outlines of the whole technique of biological control that the writer has yet seen published.

The report calls attention to the perhaps little known fact that of the 183 worst known enemies existing in North America practically half have been introduced from foreign countries, the larger proportion coming from Europe. The damage caused by the Hessian-fly in the United States is something like 800,000 pounds each year, while the cost of the by no means complete control of the Gypsy Moth, accidentally introduced into the United States some 60 years ago, is costing that government something like 50,000 pounds per annum. The European Corn Borer, an unwelcome immigrant to the United States but a decade and a half ago, is the cause of appropriations aiming at its control of around 100,000 pounds annually, altho in the single year of 1927 alone 2,000,000 pounds were expended in an attempt to arrest its spread. The loss or expense now being caused in the United States by the Oriental Peach Moth, the Japanese Beetle and the quite contemporaneous Mediterranean Fruit Fly serves to demonstrate the enormous field for the biological control of such pests.

Dr. Thompson emphasizes the need of preparatory work when the entomologist is requested to utilize the method of biological control in order to prevent damage by any pest. Of course, the first step is the accurate diagnosis of the cause of the injury and in this connection the vital importance of ready access to the councils of experienced systematists and to adequate collections and libraries is stressed. Next must come a thoro study of the literature and tabulating of the information thus obtained and then the preliminary field survey as indicated by the data in hand. The mapping out of bio-climatic areas, even tho, due to lack of complete data, this must be done quite roughly, is one of the first essentials in planning a satisfactory preliminary survey, inasmuch as frequently under one set of edaphic conditions a certain parasite may be more or less effectually controlling its host, while under a different set of conditions this particular parasite may be of no practical value. After it has been decided in just what regions the preliminary collections shall be made, the points within that region likely to give a representative idea of the conditions as a whole must be selected. It is desirable to have in headquarters a collection of the most important works dealing with the climatic, agronomic and biological characteristics of the main areas in which the work is to be carried out, also as complete a collection as possible of detailed and accurate maps. Once the survey and conclusions have been made, the examination of the material at the laboratory logically follows, with particular attention to proper determination of parasites and hyperparasites, after which the choice of the species to be utilized can be made as well as the decision as to the advisability or otherwise of introducing several parasitic species simultaneously or attempting to obtain a certain measure of control thru the initial use of one promising species to be supplemented at later dates by the introduction of others. Apparently the policy of the Farnham House Laboratory in general is to introduce one natural enemy at a time and observe the effect of this before proceeding further.

Now comes the large-scale collection and shipment of the parasites or predators, and under this heading there are complete and practical suggestions given for the speedy and economic conduct of this very important phase of the operations. The section on the method of treatment on reception and that on the study of the progress of introduced parasites in the field are also carefully and illuminatingly discussed.

This section of the report concludes with a highly theoretical and yet clearly put discussion of the results of experiments in biological control in general. Many interesting mathematical considerations as well as strictly biological ones are included in this section but the whole subject is such a complicated and involved one that no attempt may be made to review it in this limited space.

Appended to the report is an excellent bibliography of biological control of agricultural pests in which are listed 95 articles selected from the voluminous and somewhat chaotic literature of the subject.

A. H. Rosenfeld

Current Notes

W. C. Kelley, Alabama Polytechnic Institute, has been appointed Instructor in Zoology-Entomology during the absence of Professor F. S. Arant.

Prof. Geo. A. Dean returned to Manhattan, Kansas, on Sept. 29th, after a three months' visit to various sections of Europe—from Sweden to Italy.

F. H. Shirck Bureau of Entomology has been transferred from Toppenish, Wash., to Parma, Idaho, and K. E. Gibson has been transferred from Walla Walla, Wash., to Toppenish, Wash.

The Department of Zoology-Entomology, of the Alabama Polytechnic Institute, has completed a copper wire insectary, consisting of eight compartments, to augment the facilities for research in entomology.

E. E. Blanchard, Entomologist of the Department of Agriculture in Argentina, who has been attending the Pan American conference on agriculture recently held in Washington, visited the Division of Insects September 22 and subsequently.

Professor F. E. Guyton of the Department of Zoology-Entomology, Alabama Polytechnic Institute, spent the summer quarter at the Ohio State University Biological Laboratory, Put-in-Bay, Ohio pursuing graduate work toward the doctorate.

H. S. Swingle, who is in charge of the insect physiology research of the Department of Zoology-Entomology of the Alabama Polytechnic Institute has been assigned 2500 sq. ft. of new Laboratory space, which is fully equipped.

R. E. Campbell, Bureau of Entomology, in charge of the field laboratory at Alhambra, Calif., reports that Dr. N. S. Scherbinovsky, Commissariat of Agriculture of the U. S. S. R., Moscow, Russia, visited the field laboratory at Alhambra on September 2, 3 and 4.

Dr. Henry G. Good has been placed in charge of the collections of the Department of Zoology and Entomology at the Alabama Polytechnic Institute. More ample space and arrangement has recently been provided for this phase of the work.

Professor F. S. Arant, of the Department of Zoology-Entomology, Alabama Polytechnic Institute, who is on leave, has accepted a teaching fellowship at Iowa State College, Department of Zoology-Entomology, and is taking full time work toward the doctorate.

Erskine M. Livingstone was appointed Junior Entomologist, Bureau of Entomology, September 18. He graduated last June from the Clemson Agricultural College, S. C., and will assist W. D. Reed in the investigation of insects affecting cured tobacco, with headquarters at 515 Jefferson Street, Danville, Va.

Probationary appointments in the Bureau of Entomology to the several grades named have been given W. C. Cook, Entomologist, Davis, Calif., G. T. York, Junior Entomologist, Riverside, Calif., and W. B. Hollingsworth, Junior Entomologist, Picayune Miss., who have been assigned to duties at the addresses stated.

J. A. Beal, Bureau of Entomology, spent the field season at Klamath Falls, Oreg., studying the effect of various methods of slash disposal upon populations of bark beetles. He has found that piled slash breeds nearly four times as many beetles as that scattered on the ground and exposed to the sun.

Doctor A. L. Strand of the University of Minnesota has accepted the appointment as Head of the Department of Entomology, Montana State College, Bozeman,

succeeding Profeessor R. A. Coloy who will devote himself to research work. The appointment carries with it the positions of Entomologist of the Experiment Station, State Entomologist, and Secretary of the State Board of Entomology. Doctor Strand was a graduate in Entomology from Montana State College in 1917 and received his Master of Science and Doctor of Philosophy Degrees from the University of Minnesota.

C. P. Clausen, Bureau of Entomology, who has been in the Malay Peninsula and Dutch East Indies since the spring of 1929, collecting parasites of the citrus black fly, arrived in the United States September 17, with several cases of material. He spent September 18 and 19 in Washington, conferring with Bureau officials in regard to this work.

Mr. W. J. Brown, Entomological Branch, who has been collecting insects on the North Shore of the Gulf of St. Lawrence at Thunder River, Natashkwan and Bradore Bay, since the middle of June, returned to Ottawa on September 1. Mr. Brown reports a very successful collecting season, which will result in many valuable additions to the National Collection.

On July 1st the following men were promoted in rank in the Department of Entomology at the Kansas State Agricultural College: Dr. R. L. Parker was promoted to the rank of Professor of Apiculture and Entomology, Dr. R. H. Painter was promoted to an associate professorship and Mr. D. A. Wilbur was raised to an Assistant Professor of Entomology.

Dr. Emily W. Emmart, Bureau of Entomology has been appointed Assistant Entomologist, and assigned to study the morphology and histology of the Mexican fruit fly as it develops under different environmental conditions. Her headquarters will be at Mexico City, where she reported for duty September 22. Dr. Emmart recently received her doctor's degree from Johns Hopkins University.

Professor N. S. Scherbinovsky, principal entomologist of the Commissariat of Agriculture of the Union of Socialistic Soviet Republics, Moscow, Russia, visited the field laboratory at Alhambra, Calif. September 2–4 and the field laboratory at Tallulah, La., September 17 and 18.

P. H. Timberlake, of the Graduate School of Tropical Agriculture and Citrus Experiment Station, Riverside, Calif., arrived in Washington on September 16, and plans to remain for the winter, working on the classification and identification of coccinellid beetles. Special attention will be given the Keobele collection of specimens belonging to this family, which has been shipped to him in Washington from the Hawaiian Sugar Planters' Station.

A collection of Diptera, totalling approximately 12,000 specimens, has been presented to Purdue University by Dr. C. F. Adams, Director of the Bacteriological Laboratory of the Indiana State Board of Health and formerly Dean and Entomologist of the College of Agriculture of the University of Arkansas. Dr. Adams has retained the Mycetophilidae and a named set of the Culicidae, in which groups he will continue his studies.

On September 5, C. K. Fisher, Bureau of Entomology, of the bean-weevil field laboratory at Modesto, Calif., began the annual check on the infestation of the bean crop as delivered in the warehouses in California. The hearty cooperation of warehousemen and State and County agents is being extended to Mr. Fisher, as in the past. The percentage of infestation for 1930 promises to be very low as compared with that of previous years.

Donald DeLeon, Bureau of Entomology, of the field laboratory at Coeur d'Alene, Idaho, has been located at Metaline Falls, Wash., during the season, where he is making an intensive study of all insects found in association with *Dendroctonus monticolae* in white pine. The purpose of this study is to determine what insects contribute to the prevention of epidmics of Dentroctonus, in the hope that artificial control can be so directed as to take full advantage of such agencies.

Dr. L. L. English, who is located at Spring Hill, Alabama, recently conferred with the central office at Auburn regarding the completion of the new Entomological Field Research Laboratory which is being donated to the department of Zoology-Entomology by the Mobile Chamber of Commerce and the County Commissioners. The new laboratory is especially designed for research on insects affecting citrus trees and fruits. It is fireproof throughout. The laboratory equipment, and six acre experimental farm was obtained at an approximate cost of $25,000.

A. O. Larson, Bureau of Entomology, reports that examinations made in one 40-acre field in Oregon, planted for the third consecutive year in field peas, showed that 91½ per cent of all peas produced were weevily. He estimated that in this field 47, 000,000 adult weevils were left behind in the stubble after harvest. While this is an extreme case of infestation, it is sufficient to indicate the interest of northwestern farmers in the investigations on the pea weevil, of which Mr. Larson assumed charge July 1.

Dr. Arthur Gibson returned to Canada from England early in August, landing in Montreal on August 9. He reported that the Third Imperial Entomological Conference, held in London, at which representatives were present from practically all of the Dominions and Colonies of the British Empire, was a success. He also spent several days at the Farnham Royal Parasite Laboratory conferring with Dr. W. R. Thompson. Certain research stations in the neighborhood of Paris, and also the United States Parasite Laboratory at Hyeres, in southern France, were visited.

In August F. P. Keen, Bureau of Entomology, made an inspection of the National Forests of Washington. He did this to familiarize himself with insect conditions in this portion of the territory assigned to the United States Entomological Laboratory opened at Portland, Oregon., in October, 1929. Heavy damage by insects was found in various forests. The Douglas-fir tussock moth has killed thousands of acres of fir on the Colville National Forest, and the mountain pine beetle is causing severe damage to the pines both east and west of the Cascade Range.

W. B. Cartwright, Bureau of Entomology, has returned from the Orient, where he spent the last two and one-half years collecting and forwarding to the United States, parasites of the European corn borer. It will be remembered that C. A. Clark reported to Mr. Cartwright in Japan in September, 1929, in order that he might become familiar with the parasite work before taking charge of the work initiated by Mr. Cartwright. After clearing up several questions regarding the parasite work, Mr. Cartwright will resume charge of the field laboratory at Sacramento, Calif.

The latter part of July was spent by J. C. Evenden, Bureau of Entomology, of the forest-insect field laboratory at Coeur d'Alene, Idaho, in checking the results of control projects instituted last spring on the west side of Glacier National Park, and in examining areas containing new outbreaks. The results obtained by the control projects were very gratifying, as only a few newly infested trees could be found within the areas covered by control. Examination revealed several serious situations that will require control measures during the fall of 1930 and the spring of 1931.

Dr. Filippo Silvestri, Director of the Royal School of Agriculture at Portici, Italy, spent much of his time from September 6 to September 10 working on insects in the National Museum collections, with various specialists of the Bureau. He was particularly interested in termites, Zoraptera, coccids, and various myrmecophilous and termitophilous forms. Two collecting trips were made during his stay, one with Doctor Chapin, to locate living specimens of *Zorotypus hubbardi* Cdll., the other with Mr. Barber and Doctor Snyder, to search for specimens of Micromalthus, Machylis, and Spirobolus, upon which he has uncompleted manuscripts.

During a period of leave of absence in the United States, Mr. L. S. McLaine, Entomological Branch, visited the Connecticut Experiment Station, New Haven, and discussed the Asiatic and Japanese beetle situation with Dr. W. E. Britton, State Entomologist. While there he studied the methods and technique of rearing various insect parasites of the oriental peach moth. In New York City, on August 8, Mr. McLaine paid a visit to the officers of the Plant Quarantine and Control Administration regarding the European corn borer and Japanese beetle, and discussed the question of the inspection of export shipments to Canada.

A general conference on the European corn borer was held at Toledo, Ohio, September 24 and 25. The meeting this year was in many ways more comprehensive and instructive than such meetings have been in the past, although rainy weather interfered considerably with the original plans. Information was released on the status of the borer for the present season, including spread and abundance. Detailed reports were given on the various phases of research. There was the usual large attendance, representing farmers, business and banking interests, manufacturers of agricultural machinery, and State and Federal officials. A complete report of the conference is now available.

At the request of Col. D. C. Chapman, Chairman of the Tennessee Great Smoky Mountain Park Commission, Doctor Craighead and Mr. St. George, Bureau of Entomology, visited several parts of the Smoky Mountain National Park on September 10 and 11, investigating extensive outbreaks of the southern pine beetle. What is believed to be one of the largest outbreaks in recent years was found in that park. Of particular interest was an outbreak of this beetle found in spruce. This is the first record for this host in many years. Many local outbreaks in pine were found in various localities in western North Carolina and in eastern Tennessee.

The Gipsy-Moth Laboratory moved to new quarters at 1156 Main Street, Melrose Highlands, Mass., on October 15. The new location is about one-half mile from the former quarters at 17 East Highland Avenue, and can be as easily reached by railroad or by electric car from Boston. The buildings on the new site are constructed of cement blocks, and consist of two main structures and garage stalls. The largest building is being made ready for use as a laboratory, and some of the insectary buildings belonging to the laboratory have already (September 30) been moved to land adjacent to the new quarters.

The tenth annual meeting of the International Great Plains Crop Pest Committee was held under the auspices of the Dominion Entomological Laboratory, Lethbridge, Alta., on August 28–30, 1930. The meetings were held at the Greenhill Hotel, Blairmore, Alberta, and were attended by the following: Mr. H. G. Crawford, Chief of the Division of Field Crop and Garden Insects, Ottawa; Prof. R. A. Cooley and Mr. G. A. Mail, of the Montana Experiment Station, Bozeman, Montana; Dr. J. R. Park-

er, of the U. S. Bureau of Entomology, Bozeman, Montana; Dr. M. C. Lane of the U. S. Bureau of Entomology, Walla Walla, Wash.; Prof. B. H. Strickland, University of Alberta, Edmonton; Mr. S. H. Vigor, Field Crops Commissioner, Regina, Sask.; Messrs. N. Criddle and R. H. Handford, Entomological Laboratory, Treesbank, Man.; Mr. Brown of the Inspection Station, Estevan, Sask.; Mr. K. E. Stewart, Entomological Laboratory, Indian Head, Sask.; Messrs. K. M. King, E. McMillan and L. Paul of the Entomological Laboratory at Saskatoon, Sask.; Mr. E. R. Buckell of the Entomological Laboratory at Vernon, B. C.; Mr. Eric Hearle, of the Entomological Laboratory at Kamloops, B. C.; Messrs. H. L. Seamans, G. F. Manson, C. W. Farstad, R. W. Salt and J. H. Pepper, of the Entomological Laboratory at Lethbridge, Alberta; Dr. Neidig of the Consolidated Smelters, Trail B. C. and Mr. F. S. Carr of Medicine Hat, Alberta. Miss C. Coutts of the Entomological Laboratory of Lethbridge, Alberta, was secretary of the meetings.

Horticultural Inspection Notes

The Eastern Plant Board has scheduled a meeting to be held in New York City on November 24 and 25.

Mr. O. L. Cook has been transferred from the port of Nogales, Arizona, to Eagle Pass, Texas.

Mr. Joseph T. Watt has been transferred from the port inspection at Eagle Pass, Texas, to Honolulu, T. H., to assist Mr. H. F. Willard.

Mr. A. K. Pettit, who was formerly employed as a Plant Quarantine Inspector at Eagle Pass, Texas, was reinstated on September 17 for duty at the port of New Orleans.

Mr. and Mrs. R. N. Lobdell, who had for a number of years been employed by the State Plant Board of Mississippi, resigned their positions in April, 1930. They are now located at Belle Glade, Fla., where Mr. Lobdell is Entomologist of the Everglades Branch Experiment Station.

On September 3, Mr. R. W. Woodbury was transferred from Boston to assume charge of the Plant Quarantine activities at the port of Wilmington, North Carolina. Mr. J. T. Beauchamp was appointed Junior Plant Quarantine Inspector to fill the vacancy at the port of Boston, Massachusetts.

Messrs. Harry M. Cottier, Fred O. Dodd, Hubert G. Frane, William R. Fyke, John R. Garrett, Mansel C. Guerry, Clyde G. Latham, J. Guy Lewis, Milton H. Sartor, and H. G. Taylor, have been appointed as Junior Plant Quarantine Inspectors and assigned to the port of New York.

The Commissioners and Secretaries of Agriculture held their annual meeting in Washington on October 20 to 22. The work of the Plant Quarantine and Control Administration of the United States Department of Agriculture was discussed by Mr. Lee A. Strong in one of the sessions of the convention.

Mr. L. M. Fenner, until recently employed as Associate Plant Pathologist of the State Plant Board of Florida in connection with control or prevention of spread of the bacterial canker of tomato, has resigned to take postgraduate work in the Department of Botany at Ohio State University, Columbus, Ohio.

Continuing the series of circulars giving the plant quarantine restrictions of various foreign countries, the Plant Quarantine and Control Administration has issued outlines of the requirements of Brazil (PQCA-294), Union of South Africa (PQCA-297) and Australia (PQCA-299).

Under recent rules adopted by the State Plant Board of Mississippi, the shipment into that State of nursery stock from areas in other States in which the Ozonium Root Rot (*Ozonium omnivorum*) is known to occur, is prohibited, also shipments from nurseries and greenhouses known to be infested with the Japanese Camphor Scale (*Pseudaonidia duplex*).

Mr Chesley Hines, who had served as Inspector for the State Plant Board of Mississippi since January, 1927, with headquarters at Yazoo City, where he had charge of the Plant Board work in five counties, resigned on October 15, 1930, to accept the position of Fruit Specialist in the Extension Department at A. & M. College, Mississippi.

Mr. T. F. McGehee, who had for ten years been Assistant Entomologist for the State Plant Board of Mississippi with headquarters at Holly Springs, where he had charge of the Plant Board work in three counties, resigned on September 1, 1930, to accept the position of Assistant Director in charge of the Branch Experiment Station at Holly Springs, Mississippi.

A modification of the instructions for the disinfection of nursery products under the requirements of the Federal Japanese beetle quarantine regulations was issued on September 17 to authorize the lifting of plants from fields previously treated with lead arsenate, on October 1 instead of October 15, as heretofore.

Mr. R. A. Sheals of the Domestic Plant Quarantine Office of the Plant Quarantine and Control Administration spent the month of October visiting transit inspection stations in the Middle West, for the purpose of supervising the work of transit inspectors during the fall nursery stock shipping season.

The Plant Quarantine and Control Administration reports the discovery of the pink bollworm of cotton at a number of points in Arizona in the Salt River Valley, and the Gila Valley, outside the noncotton zones established by the State of Arizona early in 1930, in an attempt to eradicate the pink bollworm from that section.

Mr. B. C. Stephenson, a recent graduate of the Mississippi A. & M. College, who has been employed since March, 1930, as an inspector for the State Plant Board with headquarters at Greenwood, Miss., where he had charge of the Plant Board work in three counties, resigned on October 29, 1930, to accept an appointment in the Mexican fruit worm eradication work with headquarters at Harlingen, Texas.

A rule of the State Plant Board of Mississippi adopted in 1930 prohibits the movement into or within Mississippi of potted plants or any other plants with soil around the roots from areas known to be infested with the Argentine ant (*Iridomyrmex humilis*) except when the State Plant Board shall receive reliable information that the property on which the plants were grown is free from the ants.

Messrs. J. S. Woodard, Austin, Texas; M. S. Yeomans, Atlanta, Ga.; G. M. Bentley, Knoxville, Tenn.; R. W. Leiby, Raleigh, N. C.; P. A. Glenn, Urbana, Ill.; R. H. Bell, Harrisburg, Pa.; E. N. Cory, College Park, Md.; and W. E. Rumsey, Morgantown, Va., were among the State nursery inspection officers who attended the phony peach disease quarantine hearing at Washington, D. C., on November 14.

At a special meeting of the State Plant Board of Mississippi held on October 4, 1930, the quarantine against the sweet potato weevil, *Cylas formicarius*, was amended so as to remove from the quarantined area Baldwin County, Alabama, and the northern part of Mobile County, Alabama. The only part of Alabama that is now within the quarantined area is that part of Mobile County that lies south of the north line of Township 4 south.

Mr. W. B. Hollingsworth, a recent graduate of the Mississippi A. & M. College, who had been employed as an Inspector for the State Plant Board of Mississippi since March, 1930, resigned on September 1 to accept an appointment as Junior Entomologist in the Division of Truck Crop Insect Investigations of the United States Bureau of Entomology with headquarters at Picayune, Miss., where he is engaged in investigations on the sweet potato weevil.

During the latter part of October, Mr. E. R. Sasscer, in company with Dr. J. H. Montgomery, visited several ports of entry in Florida and also the island of Cuba. While in Cuba, Mr. Sasscer was in conference with Mr. Ernesto Sanchez Estrada concerning methods employed in safeguarding the arrival of airplanes from foreign countries. On his return trip to Washington, Mr. Sasscer conferred with the inspectors in charge at the ports of Savannah, Ga., Charleston, S. C., and Wilmington, N. C.

Because a reduced appropriation for the support of the State Plant Board of Mississippi made some reorganization of the work in that State necessary, the policy of inspecting all nurseries in the State at least three times each year has been abandoned. The present policy is to inspect all commercial nurseries at least twice each year. All citrus nursery stock is inspected at least three times each year. Small nurseries that are not large enough to be considered of commercial importance, and that do not contain citrus plants, are inspected only once each year unless there is some special reason for additional inspections.

A revision of the Japanese beetle quarantine and regulations was issued by the United States Department of Agriculture to become effective on November 10. Under the revision the entire State of Rhode Island and parts of Delaware, Massachusetts, New York, Pennsylvania, and Virginia were added to the regulated areas. The District of Columbia and small sections of Virginia, Connecticut and Pennsylvania were transferred from the lightly infested to the generally infested area, and parts of two counties in Maryland were transferred from the generally infested to the lightly infested area.

The discovery of the pink bollworm in Eddy and Otero Counties in New Mexico in October, after its apparent absence in those counties for the past two years, caused the United States Department of Agriculture, effective October 20, to reinstate the requirement of fumigation of cotton lint and linters produced in those counties as a condition for the issuance of permits for the interstate movement of cotton produced in those areas to points outside the regulated area of New Mexico. The infestations on which the new order was based were discovered at Loving, Artesia, Malaga, and Tularosa.

Prof. W. C. O'Kane, Durham, N. H., who has been in charge of Federal activities directed against the Mediterranean fruit fly in Florida since Dr. Wilmon Newell resigned as executive officer in March, relinquished his connection with that work on

October 15 to return to his duties at the University of New Hampshire. He was succeeded at Orlando, Fla., by Mr. Paul A. Hoidale, who has charge of the work conducted under the Administration against the Mexican fruit worm in Texas. Mr. M. H. Ford has been acting in charge of the Mexican fruit worm activities in Harlingen, Tex., since Mr. Hoidale's departure.

New appointees to the Federal port inspection service and the points to which they have been assigned include the following: Lionel A. Mayer, Norfolk, Va.; Geo. F. Callaghan, Erastus W. Ingle, Ralph T. Kyzar, and John P. Williamson, Brownsville, Texas; Thomas P. Chapman and Hahn W. Capps, Calexico, California; H. A. Berrier, Del Rio, Texas; T. A. Barnett, John E. Downs, and J. N. Smith, Douglas, Arizona; W. C. Goolsby, Eagle Pass, Texas; Albert E. Archer, Harry R. Conway, W. A. Harvison, and Edward Smith, El Paso, Texas; Amis L. Williamson, Hidalgo, Texas; C. L. Ritchie, Naco, Arizona; Byrd M. Ault, Edgar C. Harrison, Wm. F. Maner and W. B. R. Stromberg, Nogales, Arizona; John H. Russell, Presidio, Texas; J. F. Altstaetter, San Ysidro, California, E. L. Friday, Zapata, Texas; O. D. Morris, New Orleans; Uhl R. Kuhm, Virgil O. Miller, Bernard P. Stewart and Malcolm G. Vinzant, Laredo, Texas.

The Minister of Agriculture and Fisheries of England reports that in a number of instances shipments of plants from the United States have arrived in that country bearing State certificates which cover seasonal nursery inspection rather than inspection of the nursery stock within fourteen days prior to the date of shipment as required for the importation of plants into England and Wales. As the State plant quarantine officers of a number of States report difficulty in meeting the 14-day requirement, arrangements have been made by the Plant Quarantine and Control Administration, under the export certification act, to inspect such shipments at the port of departure in instances where State inspection is impracticable.

At a special meeting of the State Plant Board of Mississippi held on October 11, 1930, Rule 24-A was amended by the addition of the following paragraph: "The transportation through Mississippi enroute to other States of sweet potatoes, sweet potato plants, vines, cuttings, draws, and slips originating in territory, defined above as infested with the sweet potato weevil, is hereby prohibited except when accompanied by a certificate of inspection from the plant inspection official of the State of origin. This certificate must state that the sweet potatoes, or sweet potato plants were carefully inspected and found to be apparently free of the sweet potato weevil and also that the property on which the sweet potatoes or sweet potato plants were grown had recently been inspected and found to be apparently free of the sweet potato weevil."

On November 14, a hearing was held before the Plant Quarantine and Control Administration and the Federal Plant Quarantine Board to consider the extension of the quarantine on account of the phony peach disease to the States of North Carolina, South Carolina, Mississippi, Tennessee, Louisiana, Arkansas, and Texas. As an alternative to such extension, the question as to the possible discontinuance of the quarantine was also discussed. No action has yet been taken as a result of this hearing. The Administration announced that scouting work during the summer of 1930 disclosed infections, most of them incipient, in six counties in Texas, four counties in Arkansas, four parishes in Louisiana, two counties in Tennessee, one county in North Carolina, ten counties in South Carolina, and eighteen counties in Mississippi,

in addition to several counties in Alabama and Georgia, outside the areas of those States now regulated under the phony peach disease quarantine.

Mr. George L. Knight, Chief of the Division of Horticulture of the Montana Department of Labor and Industry reports that there are now sixteen inspection points in that State, each manned by an inspector who is on duty throughout the year, and that there is an additional inspector at Hamilton, Montana, making a total of seventeen field inspectors connected with his office. Of these, ten are engaged at least part of the time in inspecting incoming and outgoing nursery stock, eight represent both the Federal Bureau of Agricultural Economics and the State Division of Horticulture in the examination of apples as to quality and grade, fourteen make similar examinations of potatoes, and several in addition inspect such products as beans, lettuce, and onions as to quality and grade in addition to their work as plant quarantine officers.

The Secretary of Agriculture announced on November 17, an amendment to the pink bollworm quarantine regulations releasing from all restriction under that quarantine considerable portions of western Texas including the entire counties of Midland and Glasscock, all those portions of Dawson, Borden and Howard counties formerly under regulation, and a small portion of northeastern Midland County. No pink bollworm infestation has been found in any part of the released area at any time, except during the drop season of 1927. Surveys at that time showed some twenty different fields scattered through this area to have been subject to infestation. The eradication campaign which was immediately undertaken was apparently successful as scouting during and following the crop seasons of 1928, 1929, and 1930 have given uniformly negative results. The surveys for the season of 1930 were especially intensive due to the development of a machine which aids in separating insect material from gin trash and thereby enormously increases the rapidity with which gin trash can be examined.

The Federal Mediterranean fruit fly quarantine, relating to the transportation of Florida products susceptible to fruit fly infestation, was lifted November 15. This action completely removed all remaining restrictions on the interstate movement of host fruits and vegetables from the regulated area of Florida. Only a very few specimens of the fruit fly have been found in the State during the past fourteen months and none have been discovered since August 1, 1930. The nearly 700 inspectors employed during the late summer and fall submitted approximately 600,000 specimens for examination by the identification division but none were identified as being Mediterranean fruit fly. Prior to the removal of the regulations, three amendments were issued to the revision which had become effective on August 15. These amendments removed the sterilization requirements as to the shipment of host fruits and vegetables billed to southern and western states, the regulations requiring the cleaning of railway cars which had been used in transporting restricted articles out of the regulated area, the restrictions on the re-shipment of Florida products from northern to southern and western States, all restrictions on the shipment of host vegetables produced outside the "infested areas", and the regulation which prohibited the transportation of Florida host fruits and vegetables by trucks and other road vehicles. One of the amendments had also released three additional counties from the regulated areas. The principal restriction remaining up to the time the Federal quarantine was lifted required owners to pick up and dispose of "drops," culls and windfalls, made certain requirements as to packing house sanitation and provided for the issuance of property certificates and shipping permits. Intensive field inspection will be continued, and, if the fruit fly is discovered, the State authorities will immediately institute eradication measures.

Apicultural Notes

While in Washington recently, A. W. B. Kjosness, general manager, and O. Lende, counsel, of the Mountain States Honey Producers' Association, conferred with the members of the Bee Culture staff and other Government officials in the Department of Agriculture.

Dr. R. L. Parker appeared on the program of the Beekeepers' Short Course at Missouri University, July 22, 1930 and judged the Bee and Honey Exhibit at the Missouri State Fair at Sedalia, Mo., and the Bee and Honey Exhibit at the Nebraska State Fair.

Harry H. Laidlaw, Jr., has been appointed Minor Scientific Helper, Bureau of Entomology, and assigned to duties at the Southern States Bee Culture Field Laboratory, Baton Rouge, La., and William C. Northrup has been appointed Assistant Scientific Aid, for service at the Intermountain Bee Culture Field Laboratory, Laramie, Wyo.

Dr. W. E. Dunham, of the Ohio State University, Columbus, who has been employed temporarily as Field Assistant, working on the problem pertaining to the use of honeybees in the pollination of red clover, stopped at the Bee Culture Laboratory at Washington on September 24 to discuss various phases of his summer's work.

J. E. Eckert, Associate Apiculturist, Bureau of Entomology, of the Intermountain Bee Culture Field Laboratory, Laramie, Wyo., spent several days at the Bee Culture Laboratory, conferring with various members of the staff in regard to his work on the flight range of the honeybee, and consulting the literature in the beekeeping library.

The vice-president of the Apis Club, an international organization of apiculturists, Jean Chaneaux, of Les Arsures (Jura), France, visited the Bee Culture laboratory September 18 and 19. Mr. Chaneauz stopped at Somerset at the conclusion of a ten months' visit to beekeepers of the United States. In this time he visited practically every important beekeeping State, and had personal interviews with many of the commercial beekeepers of the country.

Notes on Medical Entomology

F. C. Bishopp, Bureau of Entomology, returned to Washington September 17, after an extended trip through various western States to gather data concerning insects affecting cattle, and ticks and mosquitoes affecting man.

Dr. W. B. Johnson, Director of the Medical and Sanitary Service of Lagos, Nigeria, visited the Washington office September 25, to confer on problems in medical and veterinary entomology in the United States.

W. G. Bruce, Bureau of Entomology, of the field laboratory at Fargo, N. Dak., has been transferred to Dallas, Tex., for the fall and winter. He reached Dallas September 18, and will continue work on cattle grubs in Texas.

Errata

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